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CONTENTS.

EDITORIAL:
International Electrical Congress . . . 465
Forest Telephones . . . 466
Electricity in Farming . . . 467
The Testing of Hard-Drawn Copper, by Lawrence Addicks . . . 468
70,000-Volt, Direct-Current Tests Made at Geneva, Switzerland, by B. F. Hirschauer . . . 472
Equipping Mines with Electricity . . . 474
Wireless Instruction at Annapolis . . . 474
The International Electrical Congress . . . 475
Convention of the Northwestern Electrical Association . . . 485
The Annual Convention of the American Street Railway Association . . . 485
The Convention of the Independent Telephone Association of the United States . . . 485
The Ninth Annual Convention of the International Association of Municipal Electricians . . . 486
The Convention of the National Electrical Contractors' Association . . . 487
The Visiting Delegates . . . 487
The Steam Turbine and Its Use, by E. C. Crocker . . . 489
Telegraph *vs.* Telephone . . . 490
The Production of Graphite in 1903 . . . 491
The Convention of the Society for Promotion of Engineering Education . . . 491
Transformer Testing for Central Stations—II. by S. E. Johanneson . . . 492
Telephone Growth in the United States as Compared with Other Countries . . . 494
Wireless Telegraphy on the Marsden . . . 494
ELECTRICAL PATENTS . . . 495
The X-Ray in Leukemia . . . 495
REVIEWS OF CURRENT ENGINEERING AND SCIENTIFIC LITERATURE . . . 495
INDUSTRIAL SECTION:
Telephone Development in New York City . . . 498
The Brown Hoisting Machine Company's Exhibit at the St. Louis Exposition . . . 498
A Large Electrically Illuminated Sign . . . 499
Hydroelectric Statistics . . . 499
The Operating Switchboard—Louisiana Purchase Exposition . . . 500
Electric Elevator for Liberty Statue . . . 501
Some Pardridge Specialties . . . 501
The Exhibit of C. H. Bradley & Company at St. Louis . . . 502
The Condensers in the Power Plant, Machinery Hall, St. Louis, Mo . . . 502
A Magneto-Call Local-Battery Switchboard Installation . . . 502
CURRENT ELECTRICAL NEWS . . . 503

INTERNATIONAL ELECTRICAL CONGRESS.

The International Electrical Congress, which was held at St. Louis, Mo., during the past week, adjourned Saturday after a most successful meeting. The work covered by the congress was broad, covering not only the theory, but all the fields of applied electricity—even therapeutics. About 160 papers were read, many of them of extreme value, and at times the discussions—in which members took part freely—were no less important. It is not possible to comment, at this time, on all the valuable contributions read there, but it may be said that in the character of the work and in the amount accomplished, this congress stands unsurpassed.

Undoubtedly, the most important work before section A (General Theory) was a discussion of units and standards. No definite conclusions were reached—nor, indeed, could this be expected—but much was accomplished in harmonizing differing opinions. Section B (General Application) covered a field too broad to bear comment in but a few words. Section C (Electrochemistry) was fortunate in having a number of foreign guests. One of the valuable contributions presented here was a paper by Dr. P. L. T. Héroult, entitled "Electrometallurgy of Iron and Steel." In section D (Electric Power Transmission) the discussion mainly turned upon the operation of systems and details of construction of transmission lines, a phase of the subject of immediate importance to transmission engineers. In section E (Electric Light and Distribution) much interest turned upon the new types of electric lamp, there being presented here papers upon the new forms of luminous electric arcs. The Nernst lamp also came in for a good share of attention. Section F (Electric Transportation) devoted much of its time to a discussion of the new single-phase commutating motors, and the application of alternating currents to railways. Here there seemed to be no doubt of the necessity for adapting alternating currents to railway service, and general confidence in the newer types of motor was evident. Some engineers, however, showed considerable conservatism, contending that thoughtless agitation of electrification of main lines would do more harm than good. Section G (Electric Communication) listened to papers on various phases of telegraphy and telephony. Probably the subject of most general interest at this time was wireless telegraphy, and here a number of noteworthy contributions were received. Section H (Electrotherapeutics) served to bring out the remarkable and invaluable aid to therapeutics resulting from the epoch-making discovery of Rœntgen.

The most important result of the meetings of the Chamber of Delegates was the decision reached to recommend to the governments represented that a permanent committee be formed of members appointed by the governments which at present have legislation affecting electrical units and standards, which committee shall consider and pass upon all proposed regulations. This committee would also consider the advisability of adopting standard apparatus, though such standards will undoubtedly be concerned with ratings and performance, and not with details of construction.

The work accomplished by the congress was large. That it was possible was due principally to the harmony which prevailed throughout the congress as a whole, and in each and every section. While differences of opinion were many and natural, the good of the science and the art was always the primary consideration. The International Electrical Congress of 1904 is now past history, but the good accomplished will have lasting benefit.

FOREST TELEPHONES.

The general impression of the purpose of the telephone appears to be in connection with its extensive installation in the cities in the whirl of the concentration of active business affairs on a large scale and amid the luxuries of affluence.

While it is, indeed, true that the telephone abounds in greatest numbers in cities, yet the sphere of the individual usefulness of the instrument is not confined to great centres of population, nor measured by vast possessions. Indeed, its purpose is, relatively, the more useful where there is an absence of resources to command other methods of rapid communication.

In the smaller towns, with sparse settlements, poor highways, and if there be street cars, their trips are at long intervals, the telephone is of relatively more local importance.

Beyond the reference to farmers' telephones, which are transforming the isolated conditions of agricultural districts in a manner which is truly philanthropical, few persons living in cities are aware of the extent to which wild forest tracts are traversed by telephone lines.

During the last few years, the lumbering business has changed from a barbarism to a science, and the woodman does "spare that tree," if it is too small for the most advantageous use, and thus provides for the continuation of the same variety of growth, instead of ruthlessly hacking the forest to a desolation, to be followed by a different growth generally of less value.

Throughout the forests, from the St. Johns to Vancouver, lumber camps belonging to the same interests are connected together and thence to the sawmills or wood pulp works at frontier towns, from which communication can be held even to the metropolis.

It was formerly the custom of each lumber interest to maintain a force of couriers, like the voyageurs of the Hudson Bay Company, and these hardy men, with knapsack, would travel twenty-five miles a day through the wilderness, over rough forest paths. Now, the mill calls each camp in turn at stated hours, and receives reports and gives instructions to the foreman, and it is not necessary to dwell on the commercial advantages of maintaining such close touch between headquarters and outposts in any enterprise. Letters are read to men snowed in the forest fifty or a hundred miles away, and answers dictated by the lumbermen to a stenographer who transcribes them at the office and then mails them to their homes.

The relative contentment among the men which is established by this frequent communication is highly advantageous to the working force, and, therefore, to their employers.

The applications of the telephone to the operations of logging are alike novel and useful. The lines are run upon forest trees along the banks of rivers and telephones which are contained in sheltering boxes are attached to trees and connected to the line.

The bête noir of logging is the collecting of the logs together at some narrow place in a turbulent stream, and piling upon each other in a "jam" to which contributions are made by every log floating down the river to this spot.

The formation of a jam results from some obstacle, and generally occurs without warning, and it requires great labor, fraught with peril, to remove the logs from their constricted position. It is frequently necessary to use dynamite and much lumber is destroyed by such explosions.

With the use of the telephone, warning of the initial formation of a jam can be given by one of the men patrolling the banks, who telephones to the men up the river to stop the further flow of logs at calm places termed "trips," and it is an easy matter to break the small jam, for which further assistance can be had by summoning men from points lower down the stream.

As soon as the small jam is removed, the men above are told through the telephone to release the logs held at the "trip" and the stream of logs is resumed.

Under former conditions a larger number of men were employed, and when a jam was begun it was necessary to send messengers from one to three miles through the forest in various directions to direct the gangs to stop the flow of logs, and others to summon help who are down the stream to come up and break the jam, which had, meanwhile, time to amplify, and then after the jam had been broken second messengers must be sent up the stream to release the logs at the "trip."

By the promptness of telephonic communication, the rate of sending logs down the stream is increased by the avoidance of delays.

Beyond this, the use of the telephone renders log driving feasible on the smaller rapid rough streams where it was formerly out of the question.

Timber dams, with large sluiceways controlled by gates, are built at suitable points and the men along the river telephone to the men at the sluiceways to open or close the gates as the water may be needed.

In the Northwest, from Spokane to Columbia Pass, the trees grow from sixty to one hundred feet in height, and from ten to thirty-six inches in diameter, and without branches for thirty feet above the ground. As in all these forest systems, the wires are attached to the trees.

A lumberman at Hoquiam, Wash., was crippled for three years by an accident in the forest, and during this invalidism he directed his lumbering operations from his sickroom by means of telephones connected to his camps and logging booms on the Chelalis river, thereby conducting a business of $250,000 a year under physical conditions which, had it not been for the telephone, would have rendered him, in his helpless disablement, dependent upon other resources, instead of being a man of affairs.

The first use of the telephone in a wild country was contemporaneous with its application in connection with telephone central stations in cities.

During the winter of 1878, the United States Signal Service maintained an observatory on the summit of Mount Washington, from which the observations were sent by telegraph.

The observers had telephones at the summit which could be attached to the telegraph line that could be similarly equipped at the base, and would talk from their lofty vantage above the

clouds to the men at the lumber camp at the base of the mountain.

While the Mount Washington highway was in constant use before the burning of the Glen House at the base, telephones were attached to a line along this road in 1881, and the operation of the stages directed in this manner.

As highways follow the lines of deer tracks, so forest telephone lines, to lumber camps in Michigan which have been succeeded by towns devoted to agriculture, which follows lumbering, have, in this way, become forerunners of the toll lines forming part of the general system connecting to the telephone central stations in thriving communities.

The first use of a telephone by Dr. Alexander Graham Bell, for any distance outside of a laboratory, was on about eight miles of wire fence in Canada.

In the open country at the West given to wheat and stock raising, the barbed wire fence serves for telephone lines.

The telephone has been of especial use in districts devoted to staple agricultural products. In the cotton-raising districts of the South, dealers in the centres have local buyers scattered throughout a large territory. The telephone operators have lists of these buyers in the service of each dealer, some of these lists numbering as high as one hundred. On receipt of the quotations for the day, the dealer asks for his list to be called up in turn by the toll operator, and the buyers receive instructions as to prices to be offered for cotton.

In the ELECTRICAL REVIEW for September 29, 1888, an electric light in a log cabin, built in connection with the political campaign raging at the time, appeared to be an anachronism which inspired our editorial on "A Lesson from a Log Cabin."

The frequent installation of the telephone in camps for recreation still continues the lesson.

When a party was coming down the west branch of the Penobscot in the wilds of Maine, the guides turned their canoes to the bank one morning to the surprise of the sportsmen who did not see any indications of rapid water to need "making a carry"; and they were still more puzzled when the guides remarked that they were going to order their supper.

One of them opened a small box of a lumberman's telephone at the side of a tree and telephoned to a camp, many miles away, stating that the party would arrive at night, and gave directions for a supper; and when their destination was reached ten hours later everything connected with the supper, including the weary tourists, was ready. And yet, there are city restaurants where telephone attachments at the tables is counted as enterprise.

The camps in the Adirondacks are frequently equipped with telephones, and the sanatoriums in the north woods and the Maine forest, where Thoreau traveled as an explorer not so many years ago, and which has never been occupied with settlement, is equipped with telephones and their circulars not merely announce the fact, but are illustrated by half-tones which give photographic evidence of the lines entering buildings.

It is submitted that the results, in comparison with other methods of communication available in either place, show that the telephone service is, relatively, more important in the forest than in the city.

ELECTRICITY IN FARMING.

The use of the electric motor for performing work on farms does not seem to have made much progress in this country. This is due, in part, to the scale on which agricultural work is mostly carried out here, but the main reason seems to be the fact that our principal farming sections are level and contain but little water power. The greater part of them are far from coal supplies, and hence fuel is expensive. Under such conditions, the horse works to the best advantage, and seems to be holding his own against mechanical power. On farms too small to support a horse, or on very large ones, mechanical power may be used to advantage. Another point in favor of the horse is the flexibility of the beast; the same animal can be used for all classes of work; hauling, plowing, driving machinery, etc., and convenience in this respect offsets a greater cost of power.

It is true that there are some isolated cases where electric power plays an important part in conducting farming operations, and in the far west, where the wheat fields are of large proportions, steam is often used; but, taken altogether, the work done on farms by mechanical power in this country, compared with that done by the power of our fathers, the horse, is small.

Electricity in Farming in Europe.

In Europe, the use of electricity in farming, while by no means extensive, still is more frequent than in this country. In Germany, a good deal of attention has been devoted to developing electrical systems for plowing and cultivating, and other countries have shown a willingness to try the new system, France, in particular, seems to be giving electricity a thorough trial. The southern part of France abounds in waterfalls; the countries have shown a willingness to try the new system. erous of these water powers have been developed for lighting and furnishing power to the neighboring towns, and an important part of the output of these stations is used on the farms. Here, motors are adapted to doing all kinds of work. They are always ready to start; they are, in general, transportable, so that they can be moved from place to place, and they consume nothing when idle. Where the farm is fairly large, it owns its own motor, and keeps it working a good part of the day. Smaller farms combine and make one motor do the work for all, carrying it about from place to place as needs require. It is possible that in this section of the country, the horse has never been an important factor, and the small farmer has been able to get his products on the market by other means.

A Profitable Field for the Country Power Station.

The sale of electric power for farming seems to be a field well worthy of being developed by electric generating stations in rural sections. The work can all be done at such times so as not to interfere with the other work of the station, and with such an understanding, a low rate could be offered, which would prove attractive to the farmers, and yet would bring in a nice profit to the station. The manager of the station could also rely upon a great increase in the use of electric power on farms and in other similar work, once it is introduced, for this has been the experience in all other lines of electrical application.

THE TESTING OF HARD DRAWN COPPER.

BY LAWRENCE ADDICKS.

Hard drawn copper is principally used in the form of wire for telephone and telegraph work and for the transmission of power. The tests to be applied, therefore, cover electrical conductivity, to ensure proper resistance, tensile strength to guarantee service on long spans, elasticity to take care of changing stresses due to variation in temperature at different seasons, and ductility to guard against undue breakage when twisting

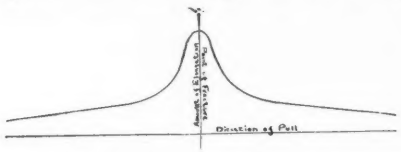


FIG. 1.—VARIATION IN ULTIMATE ELONGATION ALONG LENGTH OF WIRE.

up joints. Very large solid wires are seldom used owing to their inflexibility, stranded wire being substituted. Owing to this circumstance and to the fact that enormous quantities of wire are used in No. 12 B. & S. and adjacent sizes, the following remarks apply largely to this size, which is 0.081 inch in diameter, as typical.

Copper reaches a wire mill in the shape of pointed end wire bars, which are castings of about four by four-inch section and three feet or more in length, the dimensions varying somewhat with the weights, which run from 100 to 300 pounds in the usual sizes. These are placed in a heating furnace where, in about an hour, they are brought to a clear heat and taken to the rolls. Here the copper is given from fifteen to twenty passes through suitable grooves, reducing it to one-quarter-inch rod before it drops much below a visible temperature, or about 900 degrees Fahrenheit. This rod is coiled up and immersed for an hour in a pickling liquor, containing about ten per cent of sulphuric acid, in order to dissolve the heavy scale of oxides formed during the rolling process. It is then thoroughly washed to remove the adhering liquor and fine copper dust resulting from the reduction of cuprous oxide in the pickling tank, and finally dipped in a tallow mixture, kept fluid in a steam-jacketed pot.

The rod is now ready for the wire mill proper. It is taken to a "bull-block" and six dies are strung upon it, the largest being perhaps sixty feet from the end, the next fifty, and so on. The sizes of these dies vary somewhat at the different mills, but, provided the wire is not strained beyond its elastic limit, this has but little to do with the final result, the strength attained depending chiefly upon the percentage reduction in area and the speed of drawing. The continuous drawing machine is now strung up and the entire coil drawn down to No. 12 at one operation, the wire being turned out at the rate of about a mile in six minutes. The continuous machine consists of a row of dies placed between drawing rolls, which are speeded up to a little more than the required velocity of the wire at each point. The wire is given several turns around each roll, and the friction between the wire and the roll regulates automatically the amount of slip necessary to produce just the right speed to keep the wire under the proper tension. The dies are revolved and the drawing rolls churn through soapy water.

The rod as it leaves the rolls is but very little harder than annealed copper. It will show a tensile strength of about 33,000 pounds per square inch. The

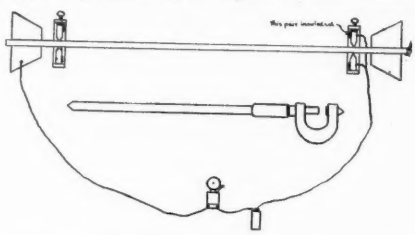


FIG. 2.—ELECTRIC CONTACT EXTENSOMETER.

transition from this to hard drawn No. 12 B. & S., running about 66,000 pounds, is gradual; wire taken from one of the intermediate dies showing properties midway between the two. If the wire were drawn at a constant speed, after passing the first die which is exceptional in its behavior, the tensile strength would show direct proportionality to the reduction in area. Increasing the speed increases the hardening action for a given reduction, but we soon reach the limiting speed from power considerations. In this way we are limited in the strength we can obtain in a given size of wire. No. 12 B. & S., for example, represents 89.5 per cent reduction in area from one-quarter-inch rod, whereas if we start with one-half-inch rod we have increased the reduction to 97.4 per cent, but at the expense of a 400 per cent increase in the area of the rod. In fine wirework the speeds are very high and strengths approximating 100,000 pounds per square inch may be reached. There is no difficulty in drawing copper from quarter-inch rod to the finest wire without any intermediate annealing.

As the strength increases, the conductivity decreases at the rate of one-tenth per cent for every 1,300 pounds per square inch. Similarly, the conductivity may be restored at the expense of the tensile strength by annealing, any intermediate stage being arrived at by regulating the temperature to which the wire is raised. This temperature must be controlled far too nicely to make the annealing furnace a practical apparatus for anything but complete softening, but the results may be easily produced experimentally by heating the wire electrically by forcing it to carry excessive currents.[1] With increasing strength the elastic limit rises, while the elongation and twisting show smaller figures.

The first and foremost test is that for conductivity, for upon it depends the value of the material for all electrical work. The conductivity is primarily an indication of the purity of the metal, although it is affected by hard drawing, as already pointed out, and may be depressed by too high an annealing temperature in the case of soft wire.[2] The uniform excellence of most electrolytic copper has made the usual conductivity requirement of ninety-six per cent hard drawn, or ninety-eight per cent soft, very easily fulfilled.[3] The copper refineries nowadays cast furnace lots ranging from 100,000 to 200,000 pounds, and as any variation in the impurities of different cathode sheets is thoroughly distributed in the melting down, and as each bar is stamped with the lot number, the wire mill has to test but one out of a great many bars to ascertain the purity of the material in use. In general, the commercial output of the refineries usually exceeds the figures stated above by a very safe margin.

When it is desired to ascertain the purity of the metal, tests should be made upon annealed samples, as they are then comparable without making any corrections. A chemical analysis of refined copper is rarely made, except in the case of defective material, where it assists in pointing out the causes of the low conductivity.

Various bridges are upon the market for testing the conductivity of wire, most of them being modifications of either the Thomson low-resistance bridge, or the Carey Foster slide wire bridge. Length-mass are much to be preferred to length-section measurements, as they are equally rapid and much more precise, especially in the case of small wires. It was formerly the custom to test samples of inordinate length, one one-hundredth of a mile, for instance, but the modern bridges seldom require more than a few feet, some taking but thirty inches. When many

wires of a certain size are tested regularly, the writer has found a differential millivoltmeter applied to the sample and standard wires in series carrying a moderately heavy, but momentary, current, inexpensive, rapid and accurate.[4] The results are universally expressed as percentages of Matthiessen's standard, which may be stated as one metre-gramme of pure soft copper equals 0.14172 international ohm at zero degree centigrade. Although this standard is several per cent below the true figure for the conductivity of pure soft copper,[5] there would be no compensating advantage sufficient to warrant any change in what may now be looked upon as an arbitrary number. In standard conductors the resistance will lie between that of a solid rod of equivalent section and that of the component wires considered separately.

The determination of the tensile strength of hard drawn copper wire is very simple. Of course, the primary requirement in every testing machine is that the load shall be applied along the geometrical axis of the specimen. This is usually accomplished with entire satisfaction by supporting the grips in yokes, which are hung from knife edges, and are, therefore, self-aligning. The duration of a test is immaterial with hard wire. The wire frequently breaks in the grips with specimens of over 40,000 pounds per square inch tensile strength. In this case the test must be repeated as the wire may have been scarred by the grip and thereby locally weakened. With softer wires the elongation of the specimen is sufficient to form shoulders at the grips, so that fracture usually occurs within the middle third. Where many wires which break at a load not exceeding 600 pounds have to be tested, a simple form of machine with direct leverage and a spring balance makes a more convenient apparatus than the heavy machines so universally used. A good warehouse balance, reading to five pounds, with a maximum finger, is all that could be desired. The length to be tested depends upon that specified for elongation, and varies from eight inches to five feet. The end of a coil where it has been drawn on the bull block when stringing up a continuous machine will have somewhat different properties from the rest of the wire and is, therefore, usually cut off and discarded at the mill. No. 12 B. & S. can be drawn as hard as 70,000 pounds per square inch, or even more, but this is not a practical value. The 65,000 or 66,000 of telephone specifications represents about the limit attainable in regular practice.

Elongation, when required, is always specified as such a per cent in a certain length, as one per cent in eight inches. This is because at the point of fracture there is a local flow of metal much greater than anywhere else along the wire. In a short length this local extension will outweigh the rest, while in a long piece it counts for less, so that results are not comparable unless from tests upon equal lengths. In softer wires the extension varies gradually from a very little at the grips to a great deal at the point of fracture, so that tests should be rejected which do not break within the middle third of the length, as beyond these limits symmetry is sufficiently disturbed to vitiate the result. Fig. 1 shows these relations in diagrammatic form. The ordinates are obtained by marking equal lengths on the specimen before testing and then measuring the percentage elongation in each of these different lengths after rupture. The abscissæ denote the position of each unit length on the specimen.

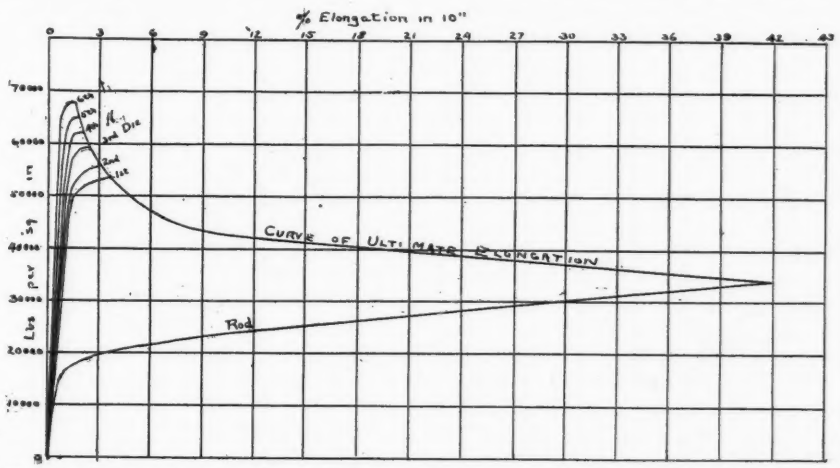


FIG. 3.—TENSILE STRESS—STRAIN DIAGRAM FOR DIFFERENT DEGREES OF HARD DRAWING.

The best method of measuring the ultimate elongation is to mark the wire slightly with a beam compass or similar device, at the specified length, then to place each of these marks near one grip, break the specimen, place the ends together and measure the distance between the gauge marks. The two pieces will never dovetail exactly, and this introduces a small but negligible error. Measurements of the amount of take-up on the straining screw should not be used, as all slippage in the grips then enters as elongation, and with short, hard pieces this error may easily give results twice too great. Elongation is not always called for in specifications. One per cent in five feet is a common value for No. 12 B. & S. In annealed wire it is about forty per cent.

When the elastic limit is to be determined, either the distance between gauge marks must be measured for successive loads until the proportionality between the stress and the strain is found to change, or that load which will just begin to produce appreciable permanent set must be ascertained by trial. The latter is the elastic limit by definition, while the former is the proportional limit, which is often assumed to be the same thing. Annealed wire has no defined elastic limit, permanent reformation following the lightest load. Stretching an annealed wire hardens it, however, and if we load such a specimen to, say, half its strength and then release it, we have the copper in a form that resembles moderately hard wire. The most convenient way to measure progressive elongation, without the use of autographic apparatus, is to scribe gauge marks as far apart as the testing machine will allow and fasten two light clips at these points. Load the wire lightly to straighten it, and then measure the distance between the clips with an electric contact micrometer, as shown in Fig. 2. Readings should be taken on both sides and averaged. Change the loads by regular intervals and repeat the micrometer measurements. Plotting the results, stress against strain, will give the characteristic curve of the material. This also gives data for calculating the modulus of elasticity, if desired. The elastic limit rises rapidly with increasing hardness in hard drawn wire. Fig. 3 shows approximate characteristic curves for copper at each stage in the drawing from rolled one-quarter inch rod through six dies to hard drawn No. 12.

We now come to ductility tests, under which head ultimate elongation might also have been classed as it measures,

to a certain extent, the ability of the metal to flow under stress. The best kind of a ductility test is to draw a sample down to fine wire, say No. 22 B. & S. If the material does not break or splinter, no more can be desired on the score of ductility. Other ductility tests are bending, wrapping and twisting.

The bending test is seldom applied to any but soft wire, where it is sometimes useful in determining whether the annealing has been thoroughly done and that therefore the wire will stand a maximum amount of vibration, as in an armature winding, without breaking. It consists of bending the wire back and forth through an angle of ninety degrees around a circular arc, the radius of which is proportioned to the size of the wire to be tested. A very convenient tool for this purpose was got up some years ago by the General Electric Company.

Wrapping consists of winding the wire closely on itself half a dozen times and then unwrapping and sometimes wrapping around a second time. The last requirement is absurd, as it is almost impossible to avoid kinking the wire and the test is needlessly severe at best. The reason for making such a test at all is that the ordinary Western Union joint is made by wrapping together the ends of the wires to be joined. A single wrapping and unwrapping around such a small diameter is certainly all that can be asked. The softer the wire the more of such treatment it will stand.

The torsion test, or twists in six inches, which long held a prominent place in all specifications for telephone wire, is one of the most delusive requirements ever prescribed. The telephone companies are at last beginning to realize this and some of them have lately abolished this test. The test is made by gripping the required length of wire between two vises, mounted like the head and tail stocks of a lathe, revolving the movable one at the rate of one turn a second, and counting the revolutions until the wire fractures. It is also customary to spline the stationary vise so that it can freely take up any change in length occurring in the specimen during test.

Eighty twists is not uncommon in wire drawn to meet the old requirement of forty twists in six inches—neither is twenty-five. The unexpected almost always happens. Consecutive lengths of the same piece of wire may differ by 100 per cent. A couple of years ago the writer devoted considerable time to an investigation of the causes of these vagaries and satisfied himself that the test bore practically no relation to the quality of the copper. The most probable cause is imperfect pickling after rolling. The scale formed in the rolls is a mixture of cupric and cuprous oxides. These are acted upon by the pickle as follows:

$$CuO + H_2SO_4 = CuSO_4 + H_2O$$

$$Cu_2O + H_2SO_4 = CuSO_4 + H_2O + Cu \text{ (in form of powder)}$$

But the liquor has no action upon metallic copper and any of the glass-hard black oxide which may have been rolled into the fibre of the metal itself is unacted upon. At any rate, before the rod goes to the wire mill it is sheathed by a very thin skin of material harder than the rest, and this difference is accentuated by the burnishing action of the dies. Immersing either the rod or the finished wire in dilute nitric acid for a short time dissolves this skin and increases the twisting the wire will stand greatly. Wire drawn from cathode copper or direct from a piece of cast copper will give as high as 150 twists in six inches. While this skin is undoubtedly harder than the rest of the metal, it is exceedingly thin and a hard drawn wire may be dissolved away in acid until it is a mere thread, without appreciably changing either the tensile strength or the conductivity.

When a very brittle material is tested to destruction by torsion, the angle of torsion may be increased until the maximum unit stress the material will stand is exceeded at the outside fibre, when the piece snaps in two. On the other hand, if the material is very ductile, the specimen does not break under this stress, but the outside fibres "flow" until the entire section reaches the maximum fibre stress. Even hard drawn copper approaches the latter case more nearly than the former. The hard envelope, or skin, however, seems to yield at one point as the test proceeds, and confines the twisting largely to a comparatively short length of the specimen. With either the cathode or the cast-rod wire mentioned above, local twisting takes place much as local elongation occurs in the tensile test, but before fracture the material flows until the entire length of the wire is twisted tightly. The action can be easily watched, as slight imperfections in the die develop as spiral elements during the test. Fig. 4 shows the characteristic torsion curves for hard drawn, annealed and cathode copper, angle of torsion being plotted against torsional moment.

A word as to the law of similarity. This law is usually stated as follows: "under identical conditions and stress, bodies of identical material and of geometrically similar shape undergo geometrically similar deformations."[6] This relation must always be taken into account when comparing tests on wires of different lengths or diameters.

In conclusion, then, hard drawn copper is always gauged by two standards, electrical conductivity and tensile strength. The first guarantees the chemical purity of the metal and the resistance calculations; the second shows the degree of hard drawing attained. It is customary to add a ductility requirement, but it must be remembered that most of the tests prescribed are directly antagonistic to the tensile strength. A certain amount can be given in each direction, but the penny and the cake too is an impossibility. Finally, the writer would call attention to the drawing test proposed for ductility in the body of this article.

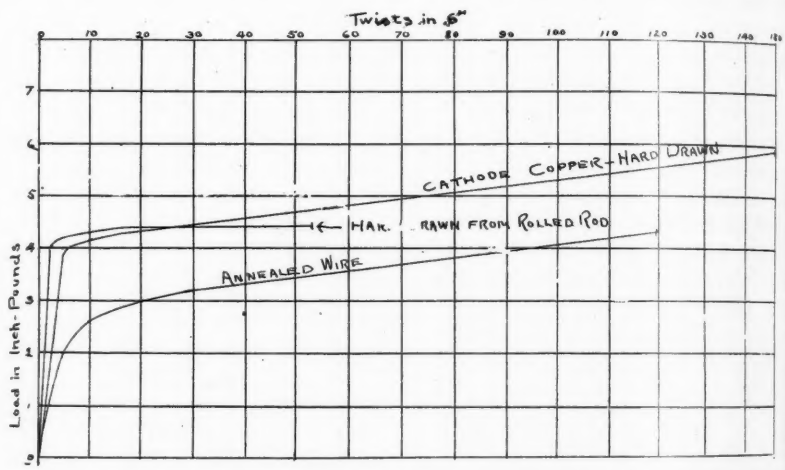


FIG. 4.—TORSIONAL STRESS—STRAIN DIAGRAM FOR NO. 12 B. & S. COPPER WIRE.

[1] For an account of experiments of this kind see paper by the writer in *Transactions* A. I. E. E., xx, 1598 *et seq.*

[2] Ibid.

[3] These two figures, of course, only agree for wire of a certain tensile strength.

[4] For a discussion of this bridge see article by the writer on "Commercial Measurement of Electrical Conductivity," ELECTRICAL REVIEW, April 12, 1902.

[5] The writer has measured annealed wire drawn directly from cathode copper running nearly 100 per cent. and has seen claims of 104 per cent.

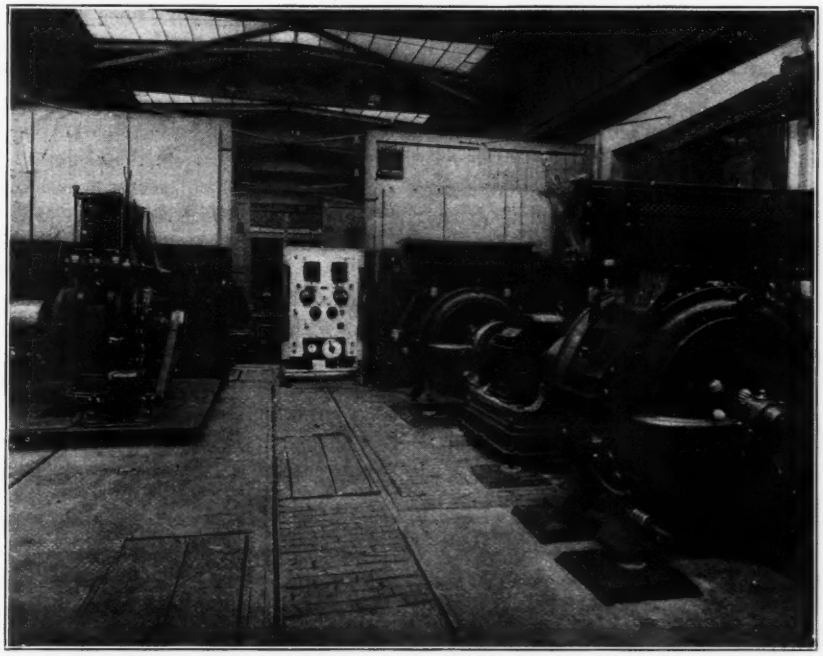
[6] For a discussion of this law the reader is referred to "Marten's Handbook of Testing Materials" (translated by Henning, Wiley Sons, New York, 1899), from which the above quotation is taken.

70,000-Volt, Direct-Current Tests Made at Geneva, Switzerland.

By B. F. Hirschauer.

THE question of the transport of force to great distances is becoming more and more important, seeing that the applications of current for lighting and traction are constantly increasing; and, on the other hand, the hydraulic forces which are situated near the place of consumption are being successively utilized, so that it becomes necessary to go to greater distances to find new ones which can be used. As an example of these conditions in Europe, it may be mentioned that the city of Zurich now has a project on foot for using hydraulic power which lies no less than eighty miles from the centre of distribution. In France, where the use of hydraulic power is constantly on the increase, it is proposed to secure a supply for Paris which will be brought from a distance of 250 miles. Other instances might be mentioned where it would be of great advantage to increase the length of the line.

In this connection, the new experiments with high voltage distribution on the direct-current system which have been carried out at Geneva under the direction of M. Réné Thury, the well-known engineer, are of special interest. M. Thury is the champion of the high-voltage direct-current system, and he seems to have proved that his ideas are correct by the successful operation of the St. Maurice-Lausanne high-tension line. This plant is one of the largest as well as the most interesting in Switzerland, and has been well described. It will be remembered that the line uses no less than 23,000 volts direct current, with a constant current of 150 amperes. This high voltage is obtained by coupling several direct-current dynamos in series. In order to test the high-tension lines the Compagnie de l'Industrie Electrique decided to build a machine which should produce 23,000 volts directly. The problem was not an easy one, owing to the numerous difficulties which were met with in producing such a high voltage. Up to the present, the highest tensions which have been obtained with direct current reach 10,000 volts. M. Thury first built a 23,000-volt machine, and as this proved a success, he proceeded to construct two others of somewhat higher voltage. Then, by connecting these three machines in series, he was able to reach the remarkably high tension of 70,000 volts direct current. It might be expected that such a high voltage would give rise to some interesting tests, and such was the case. M. Thury wished to find what would be the limiting voltage which could be used on a high-tension line in practical work. Seeing that the St. Maurice line has no difficulty with 23,000 volts and thus distributes a large amount of power to Lausanne, there seemed to be no reason why this voltage could not be considerably increased. It is naturally a question of insulation for the most part. Accordingly, the first series of tests were made in order to find out how the standard forms of line insulators would behave towards 70,000 volts direct current, and especially to compare the latter with alternating current of high voltage. As is shown by the present results, the direct current proves much superior to alternating current in regard to porcelain insulators and in general to different kinds of insulating material.



THE THREE MACHINES USED IN 70,000-VOLT TESTS AT GENEVA, SHOWING CONDENSERS MOUNTED ON GENERATORS.

The high-voltage machines will be observed in the engraving, which shows the disposition of the tests. This type of machine is a bipolar dynamo which has the external appearance of an alternator with radiating poles. The field is built of laminated iron, and revolves inside a ring which forms the armature. The latter is thus fixed and has forty-eight coils, which are inserted in the same number of slots around the periphery. The coils are insulated by paper coated with a special insulating compound. Each simple coil comprises 500 turns of copper wire 0.5 millimetre gauge, silk-covered. The whole armature thus contains 24,000 armature turns, whose resistance when the machine is running is 700 ohms. It is capable of delivering one ampere on a normal run. The coils, which are lathe-wound, can be easily placed in the armature slots or removed from the same.

The commutator of the 23,000-volt machine is made up of ninety-six segments, which are separated by air-spaces. It is fixed, contrary to the commutator of an ordinary dynamo. The current is taken from it by two small metallic brushes which run upon the inner surface of the commutator. As it was feared that arcs would be formed between the segments, seeing that there is 500 volts between each of them, a small blowing outfit was provided at first. It was mounted inside the pulley which the machine carried and which served to drive the exciter. By means of two nozzles which were placed near the brushes a strong air-blast was sent against the segments in order to blow out the arc. But when the current delivered by the machine became somewhat high there was still some danger from short-circuits. So it was finally decided to use a set of condensers, and these

are placed in shunt between each of the commutator segments. This arrangement proved highly satisfactory, and was an important factor in obtaining the desired results from these machines. These condensers will be noticed above the dynamos, with the different wires running down to the commutator.

The exciting current is furnished by a small separate dynamo, in the same way as for an alternator. The exciter will be noticed in the engraving, driven by belt from one of the large machines. It is well insulated from the ground as well as its regulating rheostat. The maximum exciting current was calculated at fourteen amperes and eighty volts, but in practice it suffices to use but eight amperes in order to obtain 23,000 volts from the dynamo at the normal rate of 600 revolutions per minute. The usual voltage which the dynamo is designed to give is from 18,000 to 20,000 volts, but it can easily be run for a few minutes at 23,000 volts, which is the maximum needed for these tests.

According to this, it seems that there would be no difficulty in building a machine for much higher voltages. It is a question of dimensions and also of cost. It was preferred to use several machines of this type placed in series, as this allowed of reaching the highest possible voltages without any other precaution than that of insulating from the ground. This latter point was obtained without any difficulty. In the present type of machine, the interior bore of the armature is fifty-eight centimetres (23.3 inches). The peripheral speed at 600 revolutions per minute is therefore 18.22 metres per second, which is a comparatively low rate, seeing that as high speeds as fifty metres are sometimes reached.

To give an idea of the tensions which are necessary for an economical transmission of power, it may be said that if we admit the use of direct current, allowing a loss of ten per cent in the line and a weight of copper of thirty kilogrammes (sixty-six pounds) per electric horse-power received from the line, an initial tension of 4,200 volts will be needed for ten kilometres distance (six miles), 42,000 volts for 100 kilometres (sixty miles), and 42,000 volts for 1,000 kilometres (600 miles). The use of the earth as a conductor allows of doubling these distances for the same voltage, loss and weight of copper, or to reduce the voltage to one-half. On the contrary the use of alternating current reduces these distances, owing to secondary phenomena which increase the loss in the line.

It became, therefore, of great interest to find out whether the advantages due to the use of direct current held good at high voltages. Seeing that no conclusive experiments had as yet been made beyond 25,000 volts, it might be asked whether some unexpected phenomena would not show themselves when this tension should be doubled or tripled in value, and whether the critical point of voltage which was practicable for industrial use would not be reached sooner than was imagined. In order to make the experiments at a much higher voltage than had been heretofore used, three special dynamos were coupled in series. Each of these machines was of the high-voltage type constructed specially according to M. Thury's designs. The first dynamo could give 20,000 volts easily, while the second and third gave 25,000 volts. In this way a voltage of 70,000 direct current could be reached. As each of the machines could give one ampere as a maximum current, from sixty to seventy kilowatts was obtained from the combination and this was a much greater power than was really needed for the experiments.

These tests were made especially to find how the different kinds of insulators would behave towards direct current compared with alternating current at these high voltages. As we now have a considerable amount of practical data about the alternating current, it was of interest to find the relation between the two kinds of current as nearly as possible. This would allow us to determine the direct-current voltages which are the equivalent of the alternating-current voltages and accordingly what distance can be used in the transmission line in each system, with equal losses and equal security.

The experiments succeeded very well, and it is to be regretted that they could not have been carried out for a longer time, but the high-voltage machines had been constructed on special orders, and had to be delivered. However, they show the possibility of some new and very interesting applications of direct current to several modern problems such as aerial telegraphy and the manufacture of introgenous products from the air. Professor Kowalski, of the Fribourg University, profited by the occasion to make a very curious series of tests relative to these two problems besides some other experiments with the use of high-voltage direct current, which it is hoped to publish before long.

To give a term of comparison, alternating current was used which was produced by a special alternator. This is a machine of seventy-five kilowatts with revolving armature. The fixed field has six poles, and the speed was kept regular at 1,000 revolutions per minute. This gave a frequency of fifty cycles. The armature is of the smooth drawn type with the flat coils placed on the surface and held by binding wire. The field poles covered two-thirds of the circumference. The electromotive force curve was taken by a revolving contact device placed on the end of the shaft. As will be noticed in the diagram Fig. 1, this curve is flattened at its summit, so that the maximum electromotive force, in place of being $\sqrt{2} \times$ the mean electromotive force (as in a sinusoid) is really only 1.255.

From the standpoint of insulation tests, this curve is extremely favorable to the alternating current. The sparking distances are reduced to a minimum and the insulators resist much better at high voltages than with the ordinary alternating currents which are used in practice. In order to verify this, the curve was altered in shape by introducing a capacity into the circuit and the results were conclusive. The sparking distances increased in a very considerable proportion. All the tests mentioned below were carried on with the direct use of the above wave without using such condensers. The variations of alternating voltage were obtained by regulating the exciting current and varying the ratio of the secondary of a raising transformer. For the direct current, the voltage was varied by using from one to three of the generators and by regulating the field excitation. The direct current, it may be remarked, can not be considered as absolutely continuous on account of the somewhat small number of commutator bars (ninety-six segments) and from the fact that the armature coils are lodged in the grooves of a Paccinotti ring, which increases the self-induction and tends to give a wave form to the current. However, it is not probable that the effect of such small waves is appreciable in this case.

In spite of the above conditions which are unfavorable for the direct current and favorable for the alternating, the final results are clearly in favor of the direct current. All the insulators, without exception, resisted much higher voltages for continuous current than for alternating current, which was to be foreseen. The same is true for all the insulating bodies which were pierced by the current. Besides, the insulators which were submitted to direct current were found never to heat to any appreciable degree. This was not the case with alternating current, and

the effect may be explained in part by the absence of capacity effects with the former current.

The porcelain insulators which were put through the tests were provided with their ordinary iron fittings. Only a small number of insulators and these of small size, were perforated. The spark took place in most cases at the exterior, between the binding of the line wire and the iron support. In this case it was easy to shift from direct current to alternating in making the tests. The insulators which were perforated by the alternating current were still able to resist very high voltages of direct current, in the laboratory. But when exposed to rain the limiting voltages were naturally lowered, generally about one-half.

One fact to be noted is that there is scarcely any crackling noise with direct current when the limiting tension of breakdown is approached; the reverse is true for alternating current, which is often accompanied by a considerable noise. In the same way, brush discharges are hardly appreciable with direct current except when the explosive distance is nearly reached. Between two wires at fifty centimetres (two inches) apart, nothing is observed, even at more than 60,000 volts direct current. Sharp points, however, give a slight brush discharge. Relative to the sparking distance between the points, these brush discharges prepare for the passage of the spark. The latter then occurs in such an irregular manner that it was not possible to trace a curve which should be reasonably correct for the sparking distance between the points. The differences in these distances often reached from one to four.

It was not found possible to pierce the porcelain insulators used in telegraphy, even at 65,000 volts, as well as some others which are used in high-tension lines in Europe with a moderate voltage. In the present tests it is sufficient that the porcelain be well vitrified and homogeneous, and the thickness is of little importance. As long as we are within the sparking distance, this suffices, and as this distance is shorter for the direct current, this explains why we must use direct-current voltages which are much higher in order to break down the insulation.

Glass is very difficult to pierce with direct current. Ordinary white glass of 0.12 resists very well at 25,000 volts, and is only perforated when an oscillatory discharge is formed by means of a condenser. A sheet of window glass will resist 60,000 volts direct current and no doubt still higher voltages.

What is of importance to note is that the present tests have fully confirmed the points which were only partially noted at the time of making the previous tests upon the transmission line from the hydraulic plant of St. Maurice to Lausanne (5,000 horse-power, 22,000 volts direct current). The latter tests already showed that the loss from insulation, even in time

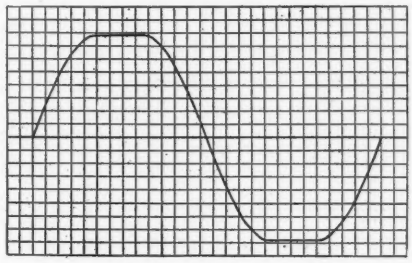


FIG. 1.—ALTERNATING-CURRENT WAVE USED AT GENEVA TESTS.

of fog, is practically zero at a voltage of 22,000 (0.02 watt per insulator of line), and it was to be foreseen that this voltage could be greatly increased before the losses by air and insulation would be appreciable. It seems certain at present that the limit voltage which we can not exceed with the material we now possess is much above 70,000 volts for direct current, between the line and the ground. This fact makes the experiments which were carried on at Geneva extremely valuable, as it throws new light upon this important question. Thus the use of direct current enables us to reach, industrially and very economically, distances which are more than double those which are attained with great difficulty by means of polyphase currents. That is to say, by the use of direct current, we can now reach a distance of

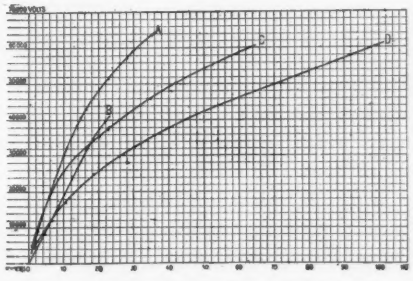


FIG. 2.—SPARKING DISTANCES, DIRECT CURRENT.

A—Two Spheres; B—Point — and Plate +; C—Plate +, Ball —, and Vice Versa; D—Point + and Plate —.

200 miles with only ten per cent loss and sixty-five pounds of copper per horse-power transmitted. As high as 600 miles is covered with the same weight of copper and somewhat less than thirty per cent loss.

The importance of this question can scarcely be overestimated, especially if it is remembered that Switzerland alone, in spite of the small extent of its territory, expends yearly for the coal used in the locomotives more than $3,000,000, which is paid to other countries, when the hydraulic power it possesses would, no doubt, allow it to economize this whole sum, besides much more. The same remark applies to many other countries, and the question is of interest wherever water power is to be found.

The results of the experiments made at Geneva may be summed up as follows:

First series. Direct current.—*Sparking distance.* The results differ according to the nature of the electrodes between which the spark took place and the polarity of the electrodes. The four curves which are shown in Fig. 2 are obtained by the disposition of electrodes which gives the most constant results. The spark between two points is quite variable and it is impossible to trace a good curve. In the present curves, a point, sphere or plate is used as an electrode, as is specified below the curve.

A point to be remarked is the great influence of polarity in the case of electrodes which are formed by a point and a plate. While at 40,000 volts the negative point gives a sparking distance of twenty-two millimetres; this distance is raised to forty-four millimetres, or double, when the point is positive. The shortest distances are obtained between spheres (diameter, twenty millimetres), or thirty-one millimetres at 60,000 volts, and the greatest distances between a + point and a plate, or ninety-nine millimetres at 60,000 volts, three times the value of the former case.

Second series. Alternating current of fifty cycles.—The results are shown in the curve, Fig. 3. The same difference is observed between curves *a* and *c*. The former curve shows the spark passing between two spheres at a distance not above seventy-four millimetres for 60,000 volts. It passes with the same voltage at 149 millimetres between point and plate. The mean ratio of sparking distance alternating current and direct current is respectively as follows in the different cases:

Two spheres at 30,000 volts, ratio 1.6; at 60,000 volts, ratio 2.5

Plate and sphere at 30,000 volts, ratio 2.4; at 60,000 volts, ratio 1.85.

Point and plate at 30,000 volts, ratio 2.2; at 60,000 volts, ratio 1.51.

These ratios hold good even though the maximum tension of the alternating current is but 1.255 times the mean tension, as the wave-form shows. This is explained partly by the fact that the sparking distance increases more rapidly than the voltage. This ratio is much higher when we use the current from a central station,

on account of the irregular form of the electromotive force curve which is due to the working of alternators in parallel or other reasons.

Third series. Tests of porcelain insulators of standard types, submitted in turn to alternating and direct current voltages, which are gradually increased until a short-circuit occurs between the line wire and the iron bracket.—The latter is always connected with one pole. These tests are made in two distinct series, one in the laboratory, on dry and clean insulators; the second in the open air on insulators exposed to the weather during a certain time. Owing to a rainfall during an entire day the tests could be made upon insulators which were quite wet. As will be noticed, the difference is considerable. The number of insulators tested together was too small to allow of making measurements of the energy expended with any precision, especially in the case of alternating current. A slight tendency to heating was only noticed with the alternating current at high voltage. The table below gives the results of the tests upon insulators:

Mean of the Breakdown Voltages.		Ratio of A. C. and D. C.	Remarks.
Alternating. Volts.	Direct. Volts.		
15,000	24,000	1.60	Tests made with continuous rain in the yard. Insulators were perforated.
25,000	.....	....	Tests made in laboratory in dry weather. Insulators clean and wiped dry. Short-circuit between line and bracket.
21,400	34,000	1.59	Tests in yard. Short-circuit to bracket.
42,000	.....	....	Tests in laboratory. Short-circuit.
27,000	40 000	1.48	Tests in yard. Short-circuit.
50,000	.....	....	Tests in laboratory. Short-circuit.
34,700	45,300	1.35	Tests in yard. Short-circuit.
54,000	.....	....	Tests in laboratory. Short-circuit.
31,160	40,800	1.31	Tests in yard. Short-circuit.
34,000	.....	....	Tests in laboratory. Short-circuit.

Fourth series. Tests of different kinds of insulating material taken from the storeroom and used without any previous preparation.—The first was a sheet of glazed cardboard five millimetres thick. With alternating current the results are as follows:

Time of Application.	Voltage.	Remarks.
First test 1½ minutes.....	9,000	No effect.
30 seconds.....	11,000	Spark passes through.
Second test 2 minutes.....	9,000	Strong brush discharge.
15 seconds additional.	9,000	Spark passes through.

The following results were secured when the same sheet was submitted to direct current:

Time of Application.	Voltage.	Remarks.
2 minutes.....	10,000	No effect.
2 "	15,000	"
2 "	18,000	"
2 "	20,000	"
4 "	25,000	Spark passes through.

These results show that the cardboard, which is perforated twice by the alternating current after two minutes of applying 10,000 volts alternating current, was able to resist for twelve minutes a mean tension of over 15,000 volts direct current, and only breaks down after four minutes application of 25,000 volts.

The second test was made upon a sheet of white marble twenty millimetres thick (0.8 inch). With alternating current the marble is perforated entirely after seventy-five seconds application of 20,000 volts. A second trial gave two minutes and 15,000 volts. Using direct current, the perforation is obtained only after fifteen minutes, from 10,000 to 45,000 volts, increasing the tension by 5,000 volts at a time during each two minutes. As the piece was already weakened by the previous experiment with alternating current, it showed a slight brush discharge at 10,000 volts which increased up to the breaking point of 45,000 volts.

All the substances which were tried gave analogous results. At the breaking point, the voltages which are needed with direct current are always double those of alternating current. When capacity plays an important part, the difference is still greater. This shows that the difficulties in the industrial use of high-tension currents are much less with direct than with alternating current, thus confirming what has already been seen in practice on several occasions. Thus the greater facility of insulation is noted not only for transmission lines, but also for all apparatus which is submitted to high tension, such as machines, motors and different appliances.

The problem of the transport of energy to several hundred miles has thus made a step in advance as a result of these experiments, now that the principal doubt has been settled. In the present tests it is not supposed that the industrial limit of voltage has been reached, however, and no doubt it can be raised considerably above 60,000 volts. It is hoped in the future that by constructing new machines it will be possible to make the tests with direct current at 100,000 volts, for it is only necessary to connect four of the present 25,000-volt machines in series, and this does not seem to present any special difficulty.

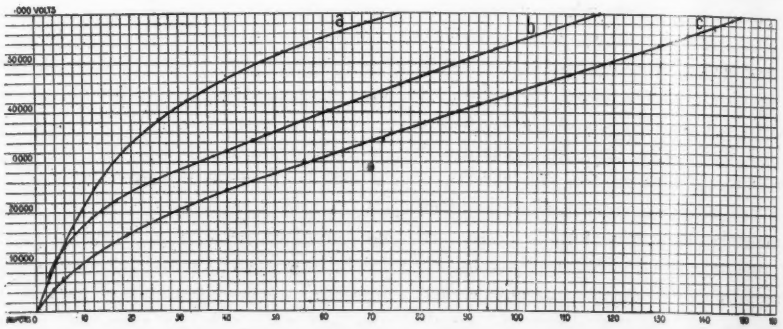


FIG. 3.—SPARKING DISTANCE, ALTERNATING CURRENT, FIFTY CYCLES.
A—Two Spheres; B—Plate and Ball; C—Plate and Point.

Equipping Mines with Electricity.

The Wolverine mines No. 2 and No. 3, near Bay City, Mich., are being equipped with electric haulage systems and generally overhauled, at an expense of $40,000. It is anticipated that the new service will augment the output of both plants nearly thirty per cent. Their capacity is now between 500 and 750 tons each day.

Wireless Instruction at Annapolis.

Instead of establishing the school for space telegraphy at the proving ground at Indian Head, Md., it will be established at Annapolis. For the use of the midshipmen and officers, a number of additional sets of wireless instruments will be installed.

THE INTERNATIONAL ELECTRICAL CONGRESS.

The Gathering of the Congress at St. Louis, September 12-17. Able Reviews of the Section Meetings. Entertainment of the Delegates and Visitors. The Circular Tour.

THE headquarters of the International Electrical Congress were opened on Monday morning, September 12, at the Coliseum, where the meetings of the congress were held. The attendance was good, there being about 900 congress members registered. After the opening ceremonies the congress broke up into sections. The first two days were devoted to the reading and discussion of papers. The report of the work accomplished during these two days was published in the issue of the ELECTRICAL REVIEW for September 17. The present report covers the proceedings of the last four days. It should be remembered that, in addition to the meetings, there was held a joint meeting of the American Institute of Electrical Engineers and the Institution of Electrical Engineers, of Great Britain, this being the annual meeting of the former. The American Electrochemical Society held a joint meeting with section C of the congress, and the American Physical Society met during the week in joint session with section A of the congress. While the main work of the sections lay along different lines, there were certain papers of general interest to two or more sections, and such papers were usually read and discussed at a joint meeting of the two sections interested.

Wednesday, September 14, was designated as Electricity Day. There was no meeting of the congress, but a joint meeting of the British Institution of Electrical Engineers and the American Institute of Electrical Engineers was held in Festival Hall to hear the presidential address. The meeting was called to order by President Arnold at 11 A. M. This was the second joint meeting of the two societies, the first being held in England in 1900 and adjourned to meet later in Paris at the Paris Exposition.

The subject of President Arnold's address was the electrification of railways. He considered the application of electricity to railway service, and showed the conditions to be fulfilled differed for different classes of work, referring briefly to notable events in the history of electric railways. Two important developments were the application of the rotary converter to railway work, enabling the power to be transferred by means of alternating currents to substations from the main station; and the use of storage batteries to absorb the variations in load. The development following the application of these methods soon showed their limits, and the necessity of developing an alternating-current motor became apparent, in order that the field of the successful electric railway might be extended. President Arnold pointed out the objections to polyphase systems, the principal ones being the objection to more than one overhead conductor, and that the characteristics of the induction motor are such that it does not lend itself to railway operation. Reference was made to the different types of alternating-current motor which have been offered for railway work, the speaker saying that we now have, or soon will have, a single-phase motor which will prove entirely satisfactory for this purpose. President Arnold explained the developments in the electrification of the New York Central & Hudson River Railroad and Pennsylvania Railroad terminals at New York city, and said that in his opinion, the decision of the committee to use direct-current motors for the former was the only one that could be reached at the time it was made, and that the commission is still convinced of the wisdom

CHAMBER OF DELEGATES, FORMED AT THE INTERNATIONAL ELECTRICAL CONGRESS, ST. LOUIS, SEPTEMBER 12, 1904.

of its decision. He then considered the extension of the application of electric propulsion to trunk lines and heavy freight service, holding, however, that at this time this is the proper field of the steam locomotives, although he expressed his confidence in the ability of the electric motor to perform the service.

At the conclusion of the address, President R. Kaye Gray, of the Institution of Electrical Engineers, of Great Britain, moved that a vote of thanks be tendered to President Arnold for his address, which was not open to criticism, since Mr. Arnold is prominent in the electric railway field. This motion was seconded by Colonel R. E. Crompton, who, in doing so, expressed his appreciation of an address worthy of the occasion. The vote was passed by acclamation.

The joint discussion upon "Different Methods and Systems of Using Alternating Current in Electric Railways" was then opened, upon the request of President Arnold, by Dr. Charles P. Steinmetz, who said that the problem was not new, but had acquired increased importance during the past year.

Dr. Steinmetz does not believe that the alternating-current motor will make inroads into the field now occupied by the direct-current motor, but that it will develop a new field, just as the alternating-current system of distribution supplemented, but did not replace, the direct-current system of distribution first used in cities.

The characteristics of the different types of motors, with reference to their applicability for railway work, were then considered. The polyphase induction motor, being a constant-speed machine with characteristics similar to the shunt motor, is not so suitable for traction as a motor having characteristics resembling those of the standard direct-current series motor. A successful railway motor, in the opinion of the speaker, must have variable speed, and its torque must decrease as the speed increases.

Railway work was divided into several classes, such as urban, elevated systems, suburban railroads, main line and long-distance freight. The conditions to be met in each class were pointed out, it being shown that for city service the series direct-current motor is entirely satisfactory. There is no reason to suppose that the alternating-current motor will replace it. For interurban service, where stops are few and distances of transmission are great, an alternating-current series motor will probably be used. For trunk line service the alternating-current commutating motor is suited, and possibly the polyphase induction motor. For freight service practically the same holds true, but there must be a large excess torque for getting under way the induction motor, and here the induction motor is deficient.

Professor John Perry thought that everything depends upon the motor itself; that the single-phase commutating motor, while apparently new, is really an old machine. Ten years ago he devised a system, but, due to the high frequency, it was found unsatisfactory.

Mr. B. G. Lamme then described the development of the alternating-current commutating motor by the Westinghouse Electric and Manufacturing Company. This type of motor had been tried from time to time, as had also the polyphase induction motor. The great objection to the latter was the multiplicity of overhead conductors, which seemed to be fatal.

Dr. C. V. Drysdale thought that we should go back to first principles before reaching a final decision, and asked whether there were not other ways of doing the work. What is required in railway operation is force, rather than power. In starting, a steam locomotive has an advantage, in that it gives force without wasting power. With direct-current motors the loss at starting is serious. He thought that the speakers were overlooking one method which met these requirements, namely, that devised by H. Ward Leonard.

Mr. Frank J. Sprague cautioned against a hasty adoption of the alternating-current commutating motor. This machine has had most diseases which afflict motors, but has been dosed until brought to its present condition. He thought that a larger and more vital problem than the one under discussion here was whether electricity should be used on trunk lines; and while he is hopeful, the question is one which can only be settled by the hard and fast rule of necessity. He believes that the largest development will be the purchase of the electric roads by the steam roads which they parallel and with which they compete.

Professor Elihu Thomson, in closing the discussion for the day, pointed out that, while there had originally been two camps—one of the believers in the alternating current, and the other of believing in the direct current—now each camp is calling on the other for assistance. He mentioned and described some early events in the history of repulsion motors, and described some of the first work in alternating-current commutating motors.

The discussion on this topic was then adjourned until Friday morning, when it was again taken up by section F.

The paper by Colonel R. E. Crompton on "The Standardization of Dynamo Electric Machinery and Apparatus" was read by the author. This paper is a history of the work of carrying out the standardization of electrical machinery in Great Britain, and gives the latest rules which have been proposed by the British standardization committee. The discussion on this paper was postponed till Thursday morning, when it was taken up by section B.

On Thursday and Friday the various sections held their meetings, at which all the papers received were read either in abstract or by title. Many of these drew forth valuable discussions, but as it is impossible to give abstracts of these papers and the discussions which would be at all satisfactory, it has seemed better to have the work of each section discussed by some one who is particularly interested in its subject. Only in this way does it seem possible to gain a fair idea of the success of the congress. It will be noticed that these discussions are not limited to the work of the last few days.

Section A—General Theory—Mathematical, Experimental.

By H. V. CARPENTER.

At a meeting of the section of the congress dealing with general theory, held in conjunction with representatives of the American Institute and the British Institution of Electrical Engineers, the discussion of our electrical units was taken up. A series of papers dealing with subjects bearing upon the general topic was first presented. Professor Moise Ascoli, president of the Italian electrical association, gave a paper entitled "Systems of Units," in which he considered the feasibility of various suggested changes in the fundamental units. He considered it possible that a system based upon some other units than the centimetre-gramme and second might be an improvement, and looked with some favor upon the plan of eliminating the troublesome "4π" from magnetic equations, by choosing the proper value for the permeability of the air or ether.

Professors Carhart and Patterson followed with an account of their work with the electrodynometer in determining the absolute value of the electromotive force of the Clark and Weston cells. This investigation has been under way for several years at their laboratory, and many difficulties have been met in getting reliable and concordant results. A number of dynamometers have been constructed, all of which are intended to measure the electric current by balancing the torque produced in the dynamometer coil, against a known torque in a heavy suspending strip of phosphor-bronze, or other suitable material. Their greatest troubles have been in getting non-magnetic materials to wind the dynamometer coils upon, and to get a suspending wire that has no elastic fatigue. The first point was settled by adopting plaster of paris, while the latter is still their chief source of error. Their results are that the value of the electromotive force of the Clark cell at fifteen degrees centigrade should be 1.433 volts, but they propose further work before making a final statement. The work of other investigators points to the same value, however, and the entire body seemed convinced that 1.433 is much nearer the true value than the legalized figure 1.434.

The situation is aggravated by the position of the German government which has in effect legalized the value 1.4328 for the same quantity.

Professor Carhart was followed by Dr. F. A. Wolff, of the Bureau of Standards, who discussed the present legal status of the ohm, volt and ampere. There seems to be no practical disagreement in regard to the value of the ohm as it is similarly defined by law in all leading nations and there seems to be little reason to doubt the accuracy of this definition. There is

also no practical difference in the value assigned to the ampere, although the laws are variously worded. In none of them, however, are the specifications for the preparation of the silver voltameter such as to ensure reproducibility within 0.1 per cent. Experiments by various investigators, including Dr. Guthe, in this country show that while the value given for the electrochemical equivalent of silver is probably very good, the method of preparation of the voltameter can be much better given than in the existing laws. These experiments show that by the later methods the ampere can be reproduced to within about one part in 20,000.

Curiously enough, the men who have been working on the Clark and cadmium cells have also found improved methods of preparing the mercurous sulphate used in them, which enable them to reproduce the volt to almost, if not quite, the same degree of accuracy. Professor Carhart has found that while the mercurous sulphate must be specially prepared to be sufficiently pure, the cadmium and cadmium sulphate may be quite impure without any serious effect upon the behavior of the Weston cell. All were agreed that if a change were to be made in the legal definition of the volt, that it should be defined in terms of the Weston normal cell, as its temperature coefficient is only one-twentieth of that of the Clark, and that the value should be nearly one part in a thousand lower than now given, and further, that the method of preparation of the cells must be completely specified.

The points so far given were apparently fully agreed upon by the congress; the discussion being mainly upon the advisability of asking the various governments to make the changes at this time. Most of the speakers were inclined to think that an error of 0.1 per cent in the definition of the practical electromotive-force standard can have no effect commercially, and that we should wait until the value is more accurately known before changing. Further, there is considerable disagreement concerning which unit, the ampere or the volt, should be specified, since all admitted that it is a mistake to give practical definitions to all three. It is plain that the standard cell is much more convenient than the silver voltameter as a standard, but the point was made that, since the primary determinations are only carried out in laboratories where accuracy is the only consideration, the point of convenience disappears and the only question to be decided is: which can be specified the more accurately? This view probably gives the voltameter a slight advantage, but further experience is needed with the new specifications for both the cell and the voltameter before this point is certain. This unsettled experimental condition is apparently the strongest reason for leaving the subject without change for the present. The suggestion to give names to the centimeter-gramme-second units of current, electromotive force, and resistance was also abandoned after a brief discussion.

Section B—General Applications.

By WM. HAND BROWNE, JR.

Section B, being concerned with the general application of electricity, necessarily took up papers upon widely varying subjects. It is therefore rather difficult to point out the most significant results of the four days' work of this section Possibly the widest discussion was provoked by the paper on "Standardization of Dynamo-Electric Machinery and Apparatus," by Colonel R. E. Crompton, delegate of the British Institution of Electrical Engineers. This paper was read at the joint meeting of the American Institute of Electrical Engineers and the Institution of Electrical Engineers, of Great Britain, held in Festival Hall on Wednesday, September 14, but at this meeting, as there was no time for a discussion, this was postponed until Thursday morning, when it was taken up in section B.

Colonel Crompton's paper first describes the work which has been carried out in Great Britain in an effort to standardize electrical machinery, and then gives in detail the recommendations which have been drawn up by the British engineering standards committee. These rules have already been published in the ELECTRICAL REVIEW. They are in good agreement with the report of the committee on standardization of the American Institute of Electrical Engineers, except in one feature: the American Institute of Electrical Engineers recognizes two standard frequencies—sixty and twenty-five; the British committee recommends one frequency—fifty—and a secondary frequency of twenty-five. Colonel Crompton said that his idea in reading his paper before the congress was to further international standardization.

In the discussion, Dr. Steinmetz pointed out the danger of legislative attempts to lay down rules for the construction of apparatus.

Mr. C. F. Scott said that the aim of the American Institute committee was to draw up a set of rules which could be regarded as good practice. It was not its intention to dictate to the constructing engineer how he should build his machinery. Regret was expressed at the difference in American and European practice in regard to frequency. It was pointed out that there is in this country nobody having authority corresponding to that of the British Board of Trade.

In replying on behalf of the British recommendations, Colonel Crompton and Dr. R. T. Glazebrook said that, while the British report had gone into much greater detail respecting the parts of machines, it was not its intention to instruct designers in the building of apparatus, but the spirit of its work was in harmony with that of the American committee, aiming, rather, to lay down rules which might be considered good practice. The particular function of the committee lay rather in prescribing ratings and performance, and not in dictating design and construction. It may be mentioned here that the report from the chamber of delegates on the question of international standardization was received with general satisfaction by the congress.

Section B held an interesting joint meeting with section F, at which the problem of adapting alternating currents to railway work was taken up. The work of this session is reported under section F.

At the meeting of section B on Monday, papers by Messrs. Mordey, Behrend, Nodon, Sharp and Jouaust were read. Mr. Mordey's paper is a study of eddies and hysteresis in iron. Mr. Nodon, under the title "Electrolytic Rectifiers," gives a brief account of this interesting device, describes its action and gives figures of the performance of rectifiers when constructed in different ways. In carrying out this work, electrodes of aluminum, cadmium, bismuth, antimony and magnesium were used in electrolytes of potassium fluoride, ammonium fluorsilicate, ammonium carbonate, ammonium oxalate, ammonium phosphate and the double phosphate of ammonium and potassium. Potassium phosphate was also tried, but this solution attacked the anodes. It was found that magnesium, cadmium, bismuth and antimony do not give rise to the valve effect. This is done by aluminum alone. Anodes are attacked when potassium or sodium salts are employed. Only the carbonate oxalate or phosphate of ammonium produces the desired result.

An interesting paper was read before this section by Dr. Clayton H. Sharp upon "The Equipment of a Commercial Testing Laboratory," in which the author describes what he considers to be the essential equipment of such a laboratory.

Professor Harris J. Ryan's paper, on "Some Elements in the Design of High-Pressure Insulation," was read before this section. The duty of predominating importance in high-pressure insulation is to withstand electrical strains. The requisite dielectric strength in low-pressure electrical apparatus is easily attained. The difficulties that must be overcome are to be found in the mechanical requirements and in the deteriorating influences of dust, temperature changes and moisture. On the contrary, in apparatus employing the higher electrical pressures, great difficulty is encountered in the provision of insulation that has ample dielectric strength to withstand continuously the electric strains that are met. For these reasons certain methods are useful in the design of insulators to withstand high electric pressures. A convenient system is necessary for fixing quantitatively the flux electric force produced by an electromotive force in a dielectric. For engineering purposes the time integral of displacement current may be conveniently employed as a measure of the strength of the corresponding electrostatic field of force. The permeability of an insulation may refer to the permeability of air, this being the dielectric flux

density per square centimetre produced by one volt applied at a distance of one centimetre. Attention must also be paid to the density of flux of electric force which the ultimate electric strength of the insulation is called upon to withstand, and at which rupture occurs. Expedients which localize the application of electric strain are considered, and experimental methods for testing the dielectric materials are described. Attention was called to the fact that a less proportionate use of mathematics can be made in determining the necessary conditions in the design of insulation than in the case correspondingly for the other two components of electrical machinery—that is, the circuits accommodating electric current and magnetism. From the inherent nature of things, the density of distribution of dielectric flux through the insulation is definite only in a few forms of electrical apparatus. In the great majority of cases, the distribution of the dielectric flux is too complex to admit of the reduction of accurate results by the simpler mathematical processes. Judgment, supplemented by the result of tests and measurements, must therefore make up the lack of calculating methods.

Herr Alexander Heyland contributed a paper to this section, on "Recent Developments in Compound Alternators with Alternating-Current Self-Excitation," and a paper upon "The Regulation of Alternators" was read by Mr. D. B. Rushmore. This considers the various elements which affect the regulation of the alternator, describes the methods of predetermining alternator regulation, and gives the results of a large number of tests.

Section C—Electrochemistry.

By PROFESSOR C. F. BURGESS.

The American Electrochemical Society held joint sessions September 13 and 15 with section C of the Electrical Congress and on the 16th with the Faraday Society of Great Britain. The papers presented constitute the most notable and interesting series of contributions made to electrochemical literature in this country —and it was unfortunate that the many counter-attractions reduced the attendance at the meetings to a number considerably less than the meetings of the American Electrochemical Society usually draw.

The foreign electrochemists who contributed to the meetings in person were, Dr. H. Goldschmidt, of the Bunsen Society of Germany; Dr. P. L. T. Heroult, of France; J. Sigfried Edström, of Sweden; and Dr. R. T. Glazebrook, of England. Other foreign contributors were, Dr. W. Ostwald and Dr. F. Haber, of the German society.

Between theory and practice the papers were evenly apportioned.

The contributions of Professor H. S. Carhart and Professor Geo. A. Hulett on "A Study of the Materials Used in the Standard Cells and Their Preparation" show that marked progress has been made toward the production of a satisfactory standard of electromotive force. The improvements consist in discovery of new methods of purifying the materials used in the construction of the standard cell.

A paper of equal importance was that of Dr. K. E. Guthe, of the National Bureau of Standards, on "The Silver Voltameter," in which it is claimed that by observing certain precautions, which were described, a practical standard for current determination is afforded by the voltameter, and one which rivals in degree of accuracy the standard cell for electromotive force determinations.

Dr. R. T. Glazebrook referred to work which he had done along this line ten years ago with Lord Rayleigh, and complimented the author on the work which he had done in summarizing the work of previous investigators, and in working out the details of the cell.

"The Lead Voltameter," by Anson G. Betts and Dr. E. F. Kern, is of interest in showing the possibility of using lead electrodes, using a solution similar to that employed in the Betts process for refining lead. The advantages claimed are convenience and cheapness of construction, and while further experimental work is necessary to determine its possibilities, it has proved to be considerably superior to the copper voltameter for commercial purposes.

"The Present Status of the Edison Storage Battery," by Professor A. E. Kennelly and S. E. Whiting, was presented in behalf of Mr. Thomas A. Edison and gave the results with the new Edison battery. The important point to be noted is that no appreciable deterioration has, as yet, been found in the batteries, and the capacity per unit of weight, over fourteen watt-hours per pound, is another advantage possessed by them. The energy efficiency is about fifty per cent on normal operation, and considerably below that value on high rates of charge and discharge. The losses of energy are due largely to the liberation of gases, and to this internal resistance of the cell. C. F. Burgess, in discussion of the paper, gave results of tests at the University of Wisconsin on Edison cells taken from automobile service, showing efficiencies below fifty per cent, and giving measurements on volumes of gases liberated during charge and discharge.

Recent improvements in the "fixation" of the nitrogen of the air were given by J. Sigfried Edström, the paper being entitled "Electrical Extraction of Nitrogen from the Air." The importance of this work is emphasized by the fact that at the present increasing rate at which sodium nitrate is being used, all known deposits will be exhausted about 1940. A new method for the production of nitrates from the air was invented less than two years ago by Professor C. Birkeland and Mr. S. Eyde, of Christiana, and in operation of the process since that time it has been demonstrated that 900 kilogrammes of nitric acid can be produced at an expenditure of energy amounting to one kilowatt-year. At present cost of nitric acid the process offers a most profitable means of utilizing electrical energy. The apparatus in which the nitrogen unites with the oxygen consists of an oven with two metal electrodes between which a high-pressure arc plays, the arc being moved rapidly by means of an electromagnetic field.

Dr. P. L. T. Heroult, well known as a pioneer and as an active worker in the use of the electric furnace, read a paper entitled "The Electrometallurgy of Iron and Steel." It was pointed out that many of the contributors to the literature on this subject were those who had done the least work upon it, and that consequently extravagant claims had been made. Under present conditions it is not possible to replace ordinary reduction methods by the electric furnace unless metal of the highest grade is required or special alloys which may sell at such price that the cost of power is unimportant may be produced.

Dr. H. Goldschmidt, of "Thermit" fame, delivered a lecture, illustrated by interesting demonstrations, on "Alumino-Thermics." The results which have been attained in the use of the "new fire" were described. These include the well-known application of thermit, a mixture of aluminum and iron oxide, to the welding of rails, pipes, etc., the reduction of various metals, and production of alloys. Newer applications were also described, these including the manufacture from aluminum oxide of a new kind of pottery having the property of indestructibility by chemicals, or by rapid variations of temperature. Thermit is being introduced as a means for cooking in military camps, and under certain other conditions where cost does not enter.

One of the most difficult problems with which the metallurgist has to deal is the reduction of sulphide ores, and Mr. James Swinburne, in his paper on "Chlorine in Metallurgy," describes his process for overcoming the various difficulties. The ore is first heated and subjected to the action of chlorine gas, the reaction producing a chloride, which is subsequently electrolyzed and the chlorine recovered for further use.

Among the papers of more theoretical interest and scientific importance are: "The Carbon Cell," by Dr. F. Haber and Dr. L. Bruner, proposes a new theory on the action of the Jacques carbon consuming cell, the action being supposed to be due to the presence of manganese. These views were strongly opposed by C. J. Reed and others who took part in the discussion.

Dr. L. Kahlenberg presented a paper dealing with the "Electrochemical Series of Elements" as determined in organic solvents.

Dr. H. E. Patten described his experiments on the deposition of aluminum from ethyl bromide solutions. These are

of interest in demonstrating the possibility of depositing aluminum at ordinary temperatures, though the particular electrolyte used does not give promise of fulfilling commercial requirements.

Dr. W. Ostwald's paper on "Electrolysis and Catalysis" was read and discussed by W. D. Bancroft.

In the absence of Professor T. W. Richards his paper on "The Relation of the Hypothesis of Compressible Atoms to Electrochemistry" was read by the chairman. Professor W. D. Bancroft rendered a service to those interested in the deposition of metals by his paper on "The Chemistry of Electroplating," in which he attempted to point out and classify the causes which lead to bad deposits. That his views are not entirely acceptable was shown by the discussions by Betts, and others, though the desirability of studying the subject in the manner suggested was agreed to.

The same author presented papers describing measurements made on the electrolytic rectifier, and also on the separation of nickel and cobalt, the latter being of interest as an analytical method.

W. McA. Johnson described the field of future application of electrometallurgical methods, and the meeting closed with a paper of scientific and practical value by FitzGerald on the "Use of Carbon as a Means for Determining Furnace Temperatures."

Section D—Electric Power Transmission.

By DR. LOUIS BELL.

Section D held four strenuous sessions. It had been quite thoughtfully located in the same dingy vaulted room with the electric lighting section, and as the only separation was a line of flags draped a few feet from the floor, the discussions of the two sections were hopelessly mixed up. The chap with the most sonorous voice fared best in the stenographer's report. But, upon the whole, the papers were valuable and the discussion, when audible, was rather illuminating. One of the most striking things in running back over the proceedings, as a whole, was the almost complete absence of any reference to transmissions at 10,000 volts or less. As a discussion-provoking voltage 10,000 has dropped out of sight—one could no more hold the section to a consideration of it than he could enthrall the National Electric Light Association by a paper on fifty-two volt lamps. The whole work of the section centred on pressures from 30,000 volts up, which is as vigorous a comment on the state of the art as one could wish.

The coast was well represented, and, perhaps, the paper which attracted the most attention was Professor F. G. Baum's on high-pressure long-distance lines with special reference to the Bay Counties and Standard lines, now consolidated with several others in the California Gas and Electric corporation. The paper is notable as an extension of Professor Baum's already published papers on the practical calculation of transmission lines, and it certainly contains more of practical value on that topic than anything in similar compass with which the writer is acquainted. Among other things, the serious question of resonance is taken up, especially the special case known as surging, and a very pretty approximate formula for the possible rise of current is presented. It is simply this, that the voltage rise is two hundred times the broken current in amperes. The very important conclusion which Professor Baum drew from this was that for equal energy, the higher the voltage the less danger from surging. It may be news, by the way, to mention that at one period the Bay Counties' plant for several weeks supplied customers over 350 miles of circuit, with entire success. The whole paper was full of valuable data, but the author of it stirred up a hornet's nest when he brought out the fact that he had practically abandoned lightning arresters, using only the horn type with wide gaps, and considered even these rather needless when using 60,000 volts or so. This brought up on their feet divers harassed victims of lightning, and for a few minutes the section room sizzled. After order was restored it became apparent, first, that on Professor Baum's system lightning is a rarity anyhow; second, that when one is insulated for 60,000 volts with anything like a decent factor of safety, he is pretty well insulated against the second-rate job lot of minor lightning discharges that work havoc on a low-tension line; third, that it is sometimes better to take trivial chances of a short-circuit from a first-class thunderbolt than to be in constant trouble from delicately set arresters that work too often. But the engineers in the lightning country were willing to take no such chances, and intimated that if the author of the paper had been up against the real thing in lightning, he would change his mind. At the next session, insulators came in for attention and this topic also wakened discussion. There was a general consensus of opinion that the thing needed in insulators was more careful design to make the best use of the material and not increase in size. One member reported having recently tested some huge insulators three feet in diameter (perpetrated by some one who didn't know any better), and that he had found them nearly useless (as might have been expected). Glass insulators, excellent at low voltages like 10,000 and 15,000, formed few friends, and the best porcelain was regarded as none too good.

So nearly as one may judge from the data elicited, it is at present possible to procure insulators that will stand a voltage of 50,000 to 60,000 with a factor of safety of somewhat less than two. Better material is needed to enable the working voltage to be raised above these figures, and as a matter of fact, no plant is yet operating commercially at a full 60,000 volts, although this figure has temporarily been surpassed, and a small number of plants use pressures above 50,000. The insulator and lightning protection questions would not down, but bobbed up at each session in some form. At the last session, the question of iron *versus* wooden pins was fervidly raised. On this topic the engineers present were greatly divided, some of large experience like Mr. Nunn trying to abolish all iron from the transmission line, even to braces and lag bolts, while others insisted on having everything metallic, except the insulators. Some reported frequent burning of wooden pins and cross-arms, while others had encountered no trouble, whatever, from that cause. Personally, the writer has a sneaking idea that when there is sufficient discharge from the insulators to burn the pins there would be something even livelier doing were both pins and cross-arms of metal. The great diversity, not only of opinion, but of experience, plainly shows the profound influence of local conditions upon the conditions of power transmission near the present limiting voltages. Taken all together it is clear that to-day the way is open for power transmission at 40,000 to 50,000 volts in any decent sort of climate and that 60,000 volts or a bit more will go successfully under favorable conditions. Higher pressures must depend on the evolution of better insulators than are just now available, while pressures of 25,000 or 30,000 volts are not materially easier to handle than those 10,000 to 20,000 volts higher save in unfavorable climates. The general sentiment of the section with respect to voltage was that one might as well be hanged for an old sheep as a lamb, or as one member very cheerfully put it, "If you're going to stay in a jack-pot you might as well be prepared to play the limit." Which maxim from our great national game may appropriately close the discussion on so thoroughly American a topic as power transmission.

Section E—Electric Light and Distribution.

By ARTHUR WILLIAMS.

The papers and discussions of section E of the International Electrical Congress will principally interest the electric light and power men of the country. This section was presided over by Mr. John W. Lieb, Jr., chairman; Senor Miguel Otamendi, C. E., official representative of Spain, honorary chairman, and Professor Jorge Newberry, representative of the Argentine Republic, and Senor R. P. Arizpe, the representative of Mexico, as honorary vice-chairmen. Mr. Gano S. Dunn was secretary of the section.

Mr. Arthur Wright, of England, the

inventor of the Wright demand meter, presented an interesting paper on "Recent Improvements in Electrolytic Meters." The paper dealt largely with the new mercury meter and its ability to record accurately under light loads. The accumulative record continuing until the meter is reset at the end of predetermined intervals, limited size, and low cost of manufacture, were additional advantages of this type. A large number are now in use by the English companies.

Mr. Wright was immediately followed by Mr. Etienne de Fodor, who presented a paper on "Rates for Electricity Supply." Mr. de Fodor, reviewing the history of rates, found that there are nearly as many rates as there are central stations. This he thought is due largely to the fact that the electric light companies are opponents of existing gas companies, and that rates had to be made and adjusted to meet the cost of gas and the local conditions covering the sale of electric current. The difference between the prevailing rates for light and power are referred to with some question as to their justification. The new "industrial" field which the gas companies have found, "establishing themselves in a position free from hazard concerning the profitable conduct of gas companies for a long time in the future," is referred to, and the percentages of gas consumed for these purposes in a number of large cities are given. At Darmstadt last year it reached as high as 46.76 per cent; at Munich, 46.60 per cent; at Düsseldorf, 43.02 per cent of the total gas generated.

The low price prevailing for electric power seemed to have produced some effect, for, in Berlin from 1902 to 1903, the number of gas motors was reduced by eighty-seven, having an aggregate capacity of 312 horse-power, while in Munich during the same year the decrease in consumption of power gas amounted to 18.68 per cent, there being a decrease of thirty-four gas motors, representing 157 horse-power. Other cities, Kaiserslautern and Baun, notwithstanding sharp competition in electric motors, showed an increase in consumption of power gas, as well as in the number of motors.

In the discussion which followed it was pointed out that any effort to restrict the growth of electric elevators (one of Mr. de Fodor's references) by high rates or otherwise would be detrimental to the general and larger interests of the supplying company; that any restriction placed upon the use of power in the so-called maximum hours of the day might involve labor questions, on the one hand, and the advantages might be offset by the elimination of electric lighting, which is rapidly gaining a foothold in the industrial establishments of our large cities; that the present relatively low prices charged for electric power arose not alone because of the character of the competition with that service, but also because of the difference in the load curve, which is practically constant throughout the working hours of every working day in the year, having the same general characteristics in the morning hours as during those of the late afternoon.

"The Protection and Control of Large High-Tension Alternating-Current Distributing Systems" was the subject of a very excellent paper by Mr. George N. Eastman. Mr. Eastman points out that the principal object to be attained in the installation of protective apparatus is continuity of service; that while the precautions that are necessary for one system may differ materially from another, the protective apparatus installed to ensure continuity of service should be substantially the same. The examples given refer particularly to the systems of the Chicago Edison Company and the Commonwealth Electric Company, which, for both, consist of a three-wire, three-phase, twenty-five-cycle, 9,000-volt primary distributing system, fed with but one exception by three-phase, star-wound generators.

Another paper which attracted a great deal of attention at the first session was that of Mr. W. C. L. Eglin, of Philadelphia, on the subject "Rotary Converters and Motor-Generator Sets." In the distributing systems of the electric supply companies in the United States, Mr. Eglin states, the demand for low-tension, direct-current service is usually of first importance. The distribution is underground by means of three-wire network, fed from substations located near the load centres, these substations being supplied with high-tension alternating current from large generating stations situated where the facilities are best for economical operation.

The percentage of the total load converted for direct current varies widely in the different localities, the difference being as much as 30 to 100 per cent. The percentage of the total load converted from alternating to direct current is so large that an effective, reliable and efficient means of transformation is essential. Three methods are available—rotary converters, motor-generator sets and rectifiers. The paper treats upon the first two methods.

The construction of rotary converters is described, with their necessary protecting and controlling devices. Rotaries may be started from either side, but preferably from the direct-current side; when starting with alternating current, from 50 to 100 per cent more than full-load current is usually required, for the regulation of which some means of control must be provided. The field also must be cut out until synchronizing speed is reached.

To avoid possibility of running away, a number of speed-limiting devices, electrical and mechanical, have been devised. One form of electrical device consists of a differential relay, one set of coils connecting to the alternating-current bus, the other set to the collector rings. Should the rotary exceed its normal speed, the frequency at the collector rings will increase, causing an unbalance at the relay, tripping the circuit-breakers. Tables giving comparative costs of the different types of apparatus and all-day efficiencies under commercial conditions conclude the paper.

"The Prussian System of Electric Train Lighting" was treated by Herr Carl Roderbourg, including the Hessian railways, all of which, until very recently, have been illuminated by oil gas on the Pintsch system, to which thirty-three and one-third per cent acetylene has been added to increase the illuminating power. A collision occurred in the latter part of 1900 in which a number of cars were set on fire, the conflagration spreading with such rapidity that many lives were lost. The public and press attributed escape of gas under the cars as the main cause, and as a result of the accident the railroad authorities decided to proceed energetically with experiments in the introduction of electric train lighting.

One type of train equipment consists of a shunt dynamo operated by a De Laval steam turbine of about twenty horse-power, mounted on the boiler of the locomotive. The turbine disc makes about 20,000 revolutions a minute; the dynamo, through a reduction gearing, one-tenth this number; 180 amperes at sixty-eight volts are generated, with a capacity somewhat in excess of this voltage for charging the storage batteries.

The batteries, which are connected in parallel with the dynamo, have thirty-two cells and a capacity of seventy-six ampere-hours at a three-hour discharge rate. They are hung under each car, and act mainly as a reserve or when the locomotive becomes separated from the train or the dynamo fails to work.

On some of the trains the dynamo is placed in the baggage car and operated from the car axle. Automatic circuit-breakers are liable to derangement from shock and do not conform to a rule to the effect that automatic switches or regulating apparatus shall not be used in electric train lighting. An electrolytic rectifying cell has therefore been substituted.

Section F—Electric Transportation.

By PROFESSOR F. C. CALDWELL.

The meetings of section F were most appropriately opened by a review of the development of the electric railway by Mr. Frank J. Sprague, aptly called by his colleagues the father of the electric railroad. This paper traces briefly the work of American and European engineers in applying electricity to the propulsion of cars. While we are accustomed to think of the electric railway as a very recent development, the first experimental work was made as far back as 1834 by Davenport. Other workers on this problem were Pope, Davidson, of Scotland; Farmer, Page, Swear and Hill, though but little advance was possible before the invention of the continuous-current dynamo in the sixties. The invention and development of this apparatus, with which the well-known names of Pacinotti, Gramme, Siemens, Wheatstone, Varley, Rowland

and Hefner-Alteneck are associated, gave renewed life to these indefatigable workers, who believed that the electric propulsion of cars was not only a mechanical possibility, but would prove to be a commercial success. Other inventors entered the field, whose names are too well known to need mention, and among these was the distinguished author of this paper, who, perhaps more than any other, is responsible for our present methods of using the electric motor for driving cars.

The road equipped by Mr. Sprague in the city of Richmond, Va., in 1887, and put into commercial operation in 1888, now stands as that pioneer road which, more than any other, was effective in the creation of the electric railway as it stands to-day.

Some of the newer plans proposed for railway work were touched upon briefly in the paper, and a few figures were given showing the enormous extent to which this method of traction has been developed in the United States. At the end of 1903, in this country alone there was a total of over 29,000 miles equipped, and on which 60,000 motors and 12,000 trail and service cars were in operation.

Probably the most notable work of section F was that relating to the application of the alternating current to railway work. This was begun on the second day with a paper by Mr. B. J. Arnold, describing the progress of the work on his electropneumatic system, the general principles of which had been previously presented to the American Institute of Electrical Engineers in June, 1902. Mr. Arnold described in greater detail the equipment and operation of his system, and said that its commercial value will depend upon the results shown by future tests, and on the relative merits of the various single-phase systems which have been developed since the announcement of the principles of this system was made public. Whatever its value may be commercially, Mr. Arnold believes that its influence in stimulating others to greater effort along new lines can not be denied, and that the art of electric railroading is one step nearer its final solution that it would be to-day had his efforts not been exerted in this attractive field of achievement, in which he has publicly, and often unsupported, proclaimed his faith in the ultimate supremacy of the alternating-current motor for railway work.

Mr. Arnold was followed by Dr. C. P. Steinmetz, with an admirable treatise, from a mathematical standpoint, of the general problem of the alternating-current motor, at the close of which he showed how the characteristics of the different forms of motors affected their application to railway work. This paper was followed by the theoretical papers of Latour, Deri, Danielson and others.

The problem of railway operation was given special prominence at the congress by being chosen as a subject for joint discussion by the American Institute of Electrical Engineers and the Institution of Electrical Engineers, of Great Britain. This was held on Wednesday, this being the annual meeting of the former society.

Mr. Arnold delivered his presidential address, which was really an introduction to the discussion. A report of the discussion which took place during the meeting will be found in the introductory chapter of this report.

The time allowed for the discussion, however, proved too short, and it was taken up again in section F on Friday. On this occasion Dr. Louis Duncan opened the discussion with his paper on the history of electric railroading. The discussion was then continued by Messrs. Sprague, Lamme, E. K. Scott, H. Ward Leonard, B. J. Arnold, Armstrong and others. This was one of the most interesting features of the sessions of section F. Two questions particularly were dwelt upon: first, to what extent the alternating-current railway motor may be expected to take the place of steam on trunk lines; second, as to whether the single-phase or the polyphase system is to be preferred. The engineers of this country will not consider for a moment a system of traction for general use requiring more than one overhead conductor. This, of course, throws out the polyphase induction motor. However, several who took part in the discussion thought that this motor might be successfully applied to hauling long-distance freight.

A number of other valuable papers were read at the meetings of this section; one by Mr. Paul Lincoln on "The Transmission and Distributing Problems Peculiar to the Single-Phase Railway" was of importance, as he considers the relative advantages of single and polyphase distribution. He calls attention to the common error, that polyphase systems are more economical of copper than single-phase; but if the terminal voltage be so adjusted that the insulation strains to ground be the same in the single and polyphase systems, then to transmit a given amount of power a given distance at a given loss will require for the single-phase line an amount of copper no greater than that required by the three-phase line.

Among the interesting papers read before this section was that by Mr. L. B. Stillwell on "Notes on Equipment of the Wilkesbarre & Hazleton Railway," and a paper by Professor Dr. Rasch on "The Booster Machine in Traction Service and Its Proper Regulation."

Dr. F. Niethammer, in a long paper entitled "Alternating *versus* Direct-Current Traction," discussed the subject from the viewpoint of the European engineer. In this he described the various alternating-current railway systems which are now undergoing investigation.

Mr. R. A. Parke contributed a short paper on "Braking High-Speed Trains."

On Friday section F met in joint session with section G (electric communication) to hear and discuss a paper presented by Mr. George F. Sever on "The Electrolysis of Underground Conductors," which contained a large amount of valuable data collected from a number of cities.

Section G—Electric Communication.

By PROFESSOR J. C. KELSEY.

Section G went into session Monday morning, September 12, with Mr. Francis W. Jones as chairman, Mr. John Hesketh, of Australia, as honorary chairman, M. Ferrie and J. C. Shields, Esq., as vice-chairmen, and B. Gherardi as secretary.

At the first session the paper by Herr Hollos, of Hungary, on "Simultaneous Telephony and Telegraphy," brought out points that either one service must of necessity be superior to the other, unless the government, for instance, runs both interests to their best efficiency.

He named some difficulties attendant to simultaneous practice, particularly connecting two distinct circuits. He advised the use of a repeating coil, which, however, cuts down the telephone efficiency, as Mr. Hollos says, weakens speaking current and calling current also. He also advised a great bridged impedance, and said even a 2,000-ohm clearing-out coil would not prevent a waste of talking current. As the talking currents are so weak they do not follow the same laws as heavy currents.

In light of the Japanese-Russian war the paper of Saitaro Oi, of Japan, was very interesting. In 1869, there were twenty miles of land lines and two telegraph stations. In 1900, there were 14,735 miles of land lines, 66,000 miles of wire, 1,654 telegraph stations, and 14,280,000 messages handled. In 1903, there were 16,600 miles of line, 80,000 miles of wire, and 2,178 stations.

In telephone work there are 14,192 subscribers in Tokyo, 6,481 in Osaka, 2,413 in Kyoto, and 1,464 in Yokohama. No party lines exist, and simultaneous telephony and telegraphy are in universal use. The rate in Tokyo and Osaka is $66 per year; in Yokohama, Kyoto and Kaba $54, which corresponds to the Bell telephone rates in America of towns of 50,000 people. Subscribers living out of the city limits pay $10 per 120 yards of line built to their place.

On Tuesday, papers were read by J. C. Barclay, Patrick Delany, Professor Lori, Dr. Potts, Colonel Reber, John Hesketh, F. J. Dommerque, Kempster B. Miller, and Dr. A. E. Kennelly. Colonel Reber spoke informally of the extent of communication in the army, of the use of sound signals in preference to tape recording, and told of the use of the Braun system of wireless telegraphy, the distance limit being about thirty miles.

John Hesketh, of Australia, brought out a peculiar condition, that of a new danger to cables. There is a beetle in Australia which takes delight in boring the cleanest hole through the lead sheath, just the size of its body. There were also samples of lead shown where the beetle apparently must have worked in hot lead, so plain is the pile of lead at the point of digging.

F. J. Dommerque read a paper on the

"Telephone Problem in Large Cities." He showed that the ideal way of giving service would be to bring all lines to a common centre, thus eliminating the trunk operator. But there is a limit to the size of the switchboard, yet a 20,000-line multiple board could take care of 10,000 single party lines, and 30,000 multiple party lines. The next proposition for larger cities would involve a divided multiple, so that 80,000 answering jacks would be available. Then the principal item of expense would be the line.

Kempster B. Miller brought out some new phases of the automatic-manual situation. Mr. Hesketh claimed that Mr. Miller was unfair in this respect; that he was comparing the manual board of to-day with the automatic system of the future.

On Thursday, papers were read by Dr. J. A. Fleming, Dr. Lee De Forest, Professor R. Fessenden, John S. Stone, Marquis Solari and H. V. Hayes.

Dr. Stone referred briefly to what may be called the popular theory of generation of electrical waves, and spoke of the exceeding complexity of the pure theory. He then showed how, by making certain assumptions, he had deduced a working theory which enabled him to compute results with considerable accuracy. A large number of diagrams were shown, indicating how closely these calculations agree with experimental measurements. This paper was excellently received, the opinion being that it would have a marked effect upon the development and application of this new art.

On Friday, the last day of the session, papers were read by M. G. de la Touanne, of Paris, Professor J. C. Kelsey, of Purdue University, and L. W. Stanton, of Cleveland.

There was a joint session with section F, when Dr. Louis Duncan presided. Professor George F. Sever gave an interesting talk on "Electrolysis," having compiled answers from numerous railways, municipalities, gas and water companies regarding conditions in general, remedy and effect.

The paper of M. de la Touanne was criticised for advocating express boards, saying that multiple service was not so quick as express.

Mr. Hesketh asked why depreciation and sinking fund charges were both made, when they practically meant the same thing.

M. de la Touanne explained French conditions, which governed the author's remarks. He said that the French subscriber bought his own instrument, that it was difficult to change conditions, and that the French government desired a system where more girls could be employed, rather than a lesser number or none at all.

The automatic *versus* the manual discussion was reopened by K. B. Miller, who explained that it was his idea that the question was the problem of the day. Mr. Dommerque related his experience, and after interviewing many subscribers of automatic systems, found that the principal factor in favor of the automatic in the people's minds is that "the girl does not talk back." Mr. Dommerque said that this was not a fault of manual systems, but one of operating.

After the papers of Professor Kelsey and Mr. Stanton were read section G was adjourned to meet with the general body at the Fair grounds on Saturday.

Certainly there never was gathered together such a group of representative men in open discussion, and the papers will certainly make a valuable addition to the literature on subjects telegraphic and telephonic.

Section H—Electrotherapeutics.

Section H, of the International Electrical Congress, devoted to therapeutics, held meetings throughout the week, and heard discussed a number of valuable papers, a list of which has already been published. The meetings were well attended, and the discussions interesting. The papers which seemed to be of the greatest importance were those by Dr. Gustave O'Farrell, on "Some Improvements in High-Frequency Generating Apparatus"; that by Dr. J. A. Riviere, of Paris, entitled "Physicotherapy of Neurasthenia"; the paper by Dr. S. Shatzky, on "The Action of the Constant Current on the Vitality of Microbes," and "A Contribution to the Radio-Diagnostics of Diseases of the Head and Brain," by Professor Maurice Benedikt, of Vienna. The latter paper described the results which have been obtained by means of X-rays in diagnosing diseased conditions of the brain. Several reproductions of photographs were shown, which indicated remarkable progress in the application of X-rays.

The paper by Dr. Shatzky described the effect of constant current on the vitality of microbes, the conclusion reached being that this current exercises a modifying influence on the vitality of these organisms and that generations which develop from microbes treated in this way have a lesser vitality than their generators.

A paper by Dr. W. J. Morton, on "Artificial Fluorescence of Human Organism as a Means of Treating Disease," was also well received and commented upon.

The Closing of the Congress—The Report of the Chamber of Delegates.

On Saturday a meeting of the congress was called to order at 10.30 A. M. by President Thomson, who then called upon Secretary Kennelly to report upon the work of the chamber of delegates. It should be stated that the chamber of delegates assembled on Monday afternoon, September 12, and organized by electing Professor Elihu Thomson president, and Dr. A. E. Kennelly secretary. The following is a revised list of the foreign officials and some official representatives who were present: Argentine Republic, Dr. Jorge Newbery; Australian colonies, John Hesketh; Denmark and Sweden, Professor Svante August Arrhenius; Dominion of Canada, O. Higman; France, Henri Poincare, Guillebot de Nerville, G. Ferrie and A. Dennery; Germany, W. Litzrodt; Great Britain, Colonel R. E. Crompton, Dr. R. T. Glazebrook and Professor John Perry; Hungary, Bela Gati and Jos Vater; India, J. C. Shields; Italy, Professor Moise Ascoli, Professor E. Lombardi and A. Maffezzini; Spain, Miguel Otamendi and Antonio Gonzales; Switzerland, Professor Ferdinand Weber; United States, Dr. H. S. Carhart, Dr. A. E. Kennelly, Professor H. J. Ryan, Professor S. W. Stratton and Professor Elihu Thomson.

Dr. Kennelly merely made a statement of the reports of the committees on international electromagnetic units and on international standardization of electrical apparatus and machinery, which reports had been unanimously adopted by the chamber. These reports follow:

REPORT OF THE COMMITTEE ON INTERNATIONAL ELECTROMAGNETIC UNITS.

The subcommittee appointed September 13, 1904, begs leave to suggest that the chamber of delegates should adopt the following report:

It appears from papers laid before the International Electrical Congress and from the discussion that there are considerable discrepancies between the laws relating to electric units, or their interpretations, in the various countries represented, which, in the opinion of the chamber, require consideration with a view to securing practical uniformity.

Other questions bearing on nomenclature and the determination of units and standards have also been raised, in which, in the opinion of the chamber, it is desirable to have international agreement.

The chamber of delegates considers that these and similar questions could best be dealt with by an international commission representing the governments concerned. Such a commission might in the first instance be appointed by those countries in which legislation on electric units has been adopted, and consist of, say, two members from each country.

Provision should be made for securing the adhesion of other countries prepared to adopt the conclusions of the commission.

The chamber of delegates approves such a plan and requests its members to bring this report before their respective governments.

It is hoped that if the recommendation of the chamber of delegates be adopted by the governments represented, the commission may eventually become a permanent one.

That the delegates report the resolution

of the chamber as to electrical units to their respective governments, and that they be invited to communicate with Dr. S. W. Stratton (Bureau of Standards, Washington, D. C.) and Dr. R. T. Glazebrook (National Physical Laboratory, Bushy House, Richmond, Surrey, England) as to the results of their report, or as to other questions arising out of the resolution.

REPORT OF COMMITTEE ON INTERNATIONAL STANDARDIZATION OF ELECTRICAL APPARATUS AND MACHINERY.

The committee of the chamber of delegates on the standardization of machinery begs to report as follows:

That steps should be taken to secure the cooperation of the technical societies of the world by the appointment of a representative commission to consider the question of the standardization of the nomenclature and ratings of electrical apparatus and machinery.

If the above recommendation meets the approval of the chamber of delegates, it is suggested by your committee that much of the work could be accomplished by correspondence in the first instance, and by the appointment of a general secretary to preserve the records and crystallize the points of disagreement, if any, which may arise between the methods in vogue in the different countries interested.

It is hoped that if the recommendation of the chamber of delegates be adopted, the commission may eventually become a permanent one.

That the delegates report the resolution of the chamber as to international standardization to their respective technical societies, with the request that the societies take such action as may seem best to give effect to the resolution, and that the delegates be requested to communicate the result of such action to Colonel R. E. B. Crompton, Thriplands, Kensington Court, London, England, and to the president of the American Institute of Electrical Engineers, New York city.

Professor Henri Poincare, who was present, then addressed the congress at the request of President Thomson.

Professor Poincare was followed by President Gray, who thought that the chamber of delegates had acted most wisely.

Professor Lombardi expressed himself as being in perfect accord with the conclusions of the chamber of delegates. He thought the question of units could not have been decided better, as a permanent committee appointed by the different governments would be the most suitable body for studying and deliberating upon the matter.

Dr. Arrhenius expressed his appreciation of the brilliant way in which the congress had been conducted. It had been a very great pleasure and a benefit to him to be able to participate in the work.

Professor A. G. Webster spoke in reference to the relation between physics and electrical energy, and he commended to the congress as the most worthy of occupations the development of science along such lines as would bring about the abolishment of war.

A vote of thanks to the St. Louis reception committee for its hospitable entertainment of the congress was proposed by Mr. J. W. Lieb, Jr., and seconded by Mr. B. J. Arnold. This was passed by acclamation.

President Thomson then, in a few words, expressed his appreciation of the assistance and evidence of good will shown by the officers and members of the congress. It had been a great privilege to have their fellowship, without which the congress could certainly not have accomplished such valuable results. The congress was then declared adjourned.

The Social Features of the Congress Week—The Circular Tour.

While there was but little need for social entertainment of the members of the International Electrical Congress during their stay at St. Louis, a number of delightful dinners and receptions were given. Besides those which have already been mentioned in the previous report, there was a most enjoyable dinner given Tuesday evening by President B. J. Arnold, at the Jefferson Hotel. The tables were laid in the south dining room of the hotel, and about 150 guests were present. They were welcomed by President Arnold, and a number of informal speeches were made.

Wednesday was designated as Electricity Day. After the joint meeting of the American Institute of Electrical Engineers and the Institution of Electrical Engineers, of Great Britain, a complimentary luncheon was given to the members of the congress by the Engineers' Club, of St. Louis, in the Electricity Building. This luncheon was followed by a complimentary automobile tour of the fair grounds, tendered by Professor W. E. Goldsborough to a large number of invited guests. In the evening there was a display of fireworks, the Palace of Electricity being illuminated and thrown open. The congress members were received by the exhibitors and viewed the exhibits, all of which were in operation.

On Thursday there was a reception by Commissioner-General Watson, of Great Britain, and Mrs. Watson, at the British pavilion on the exposition grounds. This was followed by a banquet in honor of the foreign members of the congress, held at the German national pavilion.

During the entire week the National Electric Light Association maintained headquarters at the Electricity Building on the exposition grounds, and the assistant secretary, Miss Billings, journeyed from New York to be in charge of the books of the association. Mr. Arthur Williams, of New York, vice-president, in the absence of Mr. E. H. Davis, the president of the National Electric Light Association, acted as president of the association.

The committee on arrangements for the congress should be complimented for its effective work. This committee consisted of H. H. Humphreys, chairman, Professor W. E. Goldsborough, T. K. Henderson, W. A. Layman, and the following gentlemen of St. Louis contributed to the comfort of those visiting the city: Messrs. Roger Scudder, A. L. Scudder, A. C. Harrison, A. B. Ewing, W. S. Merkle, J. W. Krueger, Henry Wrape, W. V. N. Powelson. J. I. Beggs, S. M. Dodd, M. Carlton, R. McCullough, E. G. Cowdery, W. F. Noelker, H. L. Reber, Gerard Swope, J. S. Walsh, J. E. Smith, A. S. Langsdorf.

Following are some of the representatives of electrical manufacturing companies and various mercantile electrical interests in St. Louis for the week:

J. B. Olson, sales manager of the India Rubber and Insulated Wire Company, New York. Mr. Olson was accompanied by Mrs. Olson.

The Osburn Flexible Conduit Company, New York, was represented by an efficient staff as follows: C. E. Corrigan, H. G. Osburn and Calvin Roulet. This company had headquarters at the Washington Hotel.

American Conduit Manufacturing Company, Pittsburg, C. A. Flack.

The Dale Company, New York, represented by President John Dale and O. J. Bryan.

Johnsor & Morton, Utica, W. H. Morton.

The D. & W. Fuse Company, Providence, W. S. Sisson.

John A. Roebling's Sons Company, New York, F. W. Harrington, G. W. Swan, G. H. Ivans.

DeVeau Telephone Company, New York, V. C. Gilpin.

Sawyer-Mann Electric Company, New York, C. S. Jennings.

Safety Armourite Conduit Company, Pittsburg, Robert Garland.

Hart Manufacturing Company, Hartford, represented by the Chicago manager, W. D. Crockett.

Manhattan Electrical Supply Company, New York, J. W. McDowell and F. M. Pierce, the latter of Chicago.

Faries Manufacturing Company, Decatur, Ill., W. J. Grady.

Electric Gas Lighting Company, Boston, C. E. Lee.

M. B. Austin & Company, Chicago, M. B. Austin, president.

Gould Storage Battery Company, New York, W. W. Donaldson, E. L. Draffen, A. S. Hubbard.

Keystone Electric Company, Erie, Pa., H. B. Coho.

W. R. Ostrander & Company, New York, H. E. Monk and J. A. Vaughan.

Bossert Electric Construction Company, Utica, N. Y., W. F. Bossert and W. D. Crockett.

Pass & Seymour, Solvay, N. Y., B. E. Salisbury and John W. Brooks.

Electric Appliance Company, Chicago, W. W. Low.

Franklin Electric Manufacturing Company, Hartford and New York, Charles I. Hills, president.

Hart & Hegeman Manufacturing Company, Hartford, George S. Searing, manager, Chicago office.

Crocker-Wheeler Company, Ampere, N. J., was represented by its president, Dr. Schuyler Skatts Wheeler, Gano S. Dunn, Rodman Gilder and other members of the engineering and commercial departments.

The Sprague Electric Company, New York, was represented by Alex Henderson.

Thoma & Betts, New York, H. G. Betts.

The Nernst Lamp Company, A. K. Hurst, St. Louis.

The Ewing-Merkle Electric Company, St. Louis, A. P. Ewing, W. S. Merkle, W. G. Brown, A. L. Philo, T. P. Gleeson, W. G. Sims, R. L. Faries.

The American Circular Loom Company, Chelsea, Mass., H. B. Kirkland entertained in his usual hospitable style at the Washington Hotel, assisted by Thomas H. Bibber, of Boston, and Thomas G. Grier, of Chicago.

Mr. Hugo Reisinger, the carbon importer of New York, was at St. Louis during electrical week. Mr. Reisinger is acting as a member of the jury of awards.

Dayton Electrical Manufacturing Company, Dayton, Ohio, G. Apple.

American Carbon and Battery Company, St. Louis, Henry Wrape.

American Electrical Heater Company, Detroit, B. H. Scranton, president.

The Phelps Company, Detroit, W. E. Phelps, J. W. Phelps.

The Locke Insulation Manufacturing Company, Victor, N. Y., was represented by the staff of the Wesco Supply Company, which company is the local agent for the Locke insulators.

The Wagner Electric Manufacturing Company, St. Louis, Mo., was represented by Mr. W. A. Layman and various members of its engineering and sales departments.

The Warren Electric Manufacturing Company, Sandusky, Ohio, was represented by the staff of the Wesco Supply Company, the local agent for the Warren alternators.

The Columbia Incandescent Lamp Company, St. Louis, Mo., entertained at its new factory. Mr. Garrison, president of this company, and associates were "at home" during the entire week.

The Benjamin Electric Manufacturing Company, Chicago, Ill., B. B. Benjamin.

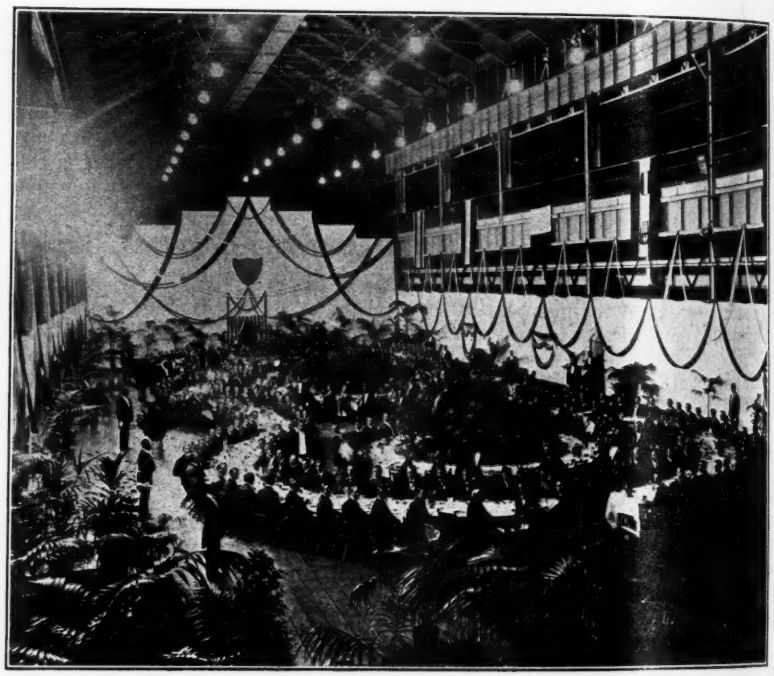
The Pardridge Shade and Reflector Company, Chicago, represented by J. S. Pardridge.

The American Diesel Engine Company, New York, was represented by Norman McCarthy, sales manager. The sixty-thousand-dollar installation of the Diesel oil-burning engines made by this company for lighting the Tyrolese Alps on the Exposition grounds attracted much attention from visiting engineers.

The Missouri American Electric Company, St. Louis, Mo., Mr. A. W. W. Miller, president, and Mr. George P. McDowell, vice-president, remained in St. Louis.

Wesco Supply Company, St. Louis, Roger Scudder and A. L. Scudder, J. E. Ecoff, N. J. Roth, F. S. Weimeyer, A. A. Marr, George F. Schminke, V. E. Raggio, R. S. Waldfield, J. W. Krueger, G. W. Cooper.

The special train carrying the foreign guests and others who participated in the circular tour, given under the auspices of the American Institute of Electrical Engineers, left St. Louis Saturday evening, and arrived in Pittsburg the following afternoon. Headquarters were established at the Hotel Schenley. The programme for Pittsburg offered a choice of six trips, special cars being provided to carry the visitors to the different works. A handsome programme was prepared by the committee, of which Mr. Charles F. Scott was chairman, showing the various trips to be made. Special cars left the Schenley Monday, September 19, 11 A. M., and luncheon was served at 1.30 at several of the works visited. During the afternoon the visitors were practically the guests of the Westinghouse companies. They were divided into small parties, and, under the escort of a large number of guides, were conducted through the shops and shown the work going on. Particular interest was manifested in the steam turbine being constructed and tested at the Westinghouse Machine Company's shops, and in the single-phase alternating-current railway motor at the plant of the Westinghouse Electric and Manufacturing Company. One of these motors, rated at 150 horse-power, was shown in operation under load. This was a 250-volt motor, and commutated beautifully, even with currents of over 1,000 amperes. Several other motors of this type were shown in the shop, and a dummy car frame had been set up with a full equipment of motors and control apparatus. In the evening the Westinghouse Electric and Manufacturing Company entertained the visitors at a large banquet, where about 400 were seated. The tables were arranged in three circles down the centre of the room, with two flanking lines. This is a new shop erected by the Westinghouse Electric and Manufacturing Company, and is over 1,760 feet in length, forming the longest shop of the company. The tables were handsomely decorated with palms and flowers, the walls of the shop were ornamented with bunting and flags, and light was supplied by forty-five Bremer arc lamps and twenty Cooper Hewitt mercury vapor lamps. The dinner ended at 9 P. M. with short speeches. Mr. George Westinghouse expressed his pleasure at being permitted to entertain the Institute and its guests. President R. Kaye Gray and Professor Moise Ascoli responded on behalf of the Institution of Electrical Engineers, of Great Britain, and the Associazione Elettrotecnica Italiana, respectively, and President Arnold, on behalf of the Institute and its guests, cordially thanked the Westinghouse companies for the courtesies shown.



THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS AND ITS GUESTS AT THE DINNER GIVEN BY THE WESTINGHOUSE ELECTRIC AND MANUFACTURING COMPANY.

At the conclusion of the dinner the party going to Washington left on a special train from East Pittsburg at 9.40. The other through trains also stopped at East Pittsburg to accommodate those who found it necessary to return directly to New York.

Leaving Washington at 8 P. M., on Tuesday, the party reached Philadelphia at 11 P. M., the same evening. On Wednesday, September 21, visits were made to various points of interest around Philadelphia, the party reaching New York on Wednesday evening. On Thursday afternoon the British visitors paid a visit to the Edison laboratory at Orange, N. J.

CONVENTION OF THE NORTHWESTERN ELECTRICAL ASSOCIATION.

ST. LOUIS, MO., SEPTEMBER 12-16.

The annual convention of the Northwestern Electrical Association was held in St. Louis, September 12-16, simultaneously with the Electrical Congress. The headquarters of the association were at the Forest Park Hotel. The president, Mr. T. R. Grover, of Fond du Lac, Wis., and Mr. Thomas R. Mercein, secretary and treasurer, of Milwaukee, were present to receive members and guests of the association from the Northwest. These gentlemen were also active in matters pertaining to the International Electrical Congress.

But one meeting was held on September 13, which was a brief and unimportant one, inasmuch as it had been decided that the association should practically merge its meeting into that of the general congress. With the exception of the address presented by President Grover, no other proceedings, except the decision to admit electric railway men as members, occurred beyond the routine. Following is the address of President Grover:

"It becomes my pleasant duty to greet you at this Fair city, now of unusual interest to the electrical fraternity by reason of the superior and attractive electrical and mechanical exhibits at this, the greatest exhibition the world has ever known.

"St. Louis, while the fourth city in the United States in population, is the commercial and financial centre of the middle states. Few cities on the globe would have the push and self-confidence to attempt this gorgeous exhibit. When you visit the Louisiana Purchase Exposition you will behold the marked advance that has been made in arts and sciences since the World's Fair at Chicago. In place of the great Machinery Hall in 1893, strewn with engines, belts and generators, we have engines and steam turbines up to 5,000 horse-power direct-connected to generators of the same capacities and occupying less than one-half the floor space. Comparing the 2,000-horse-power Corliss engine belted to two 1,000-horse-power, two-phase generators in 1893, occupying a floor space of 4,700 square feet, we may see to-day a turbine-driven alternator with 7,500-horse-power capacity, occupying less than one-fifth the floor space. I only mention these as a few of the many advances since 1893. Capital and the brain of genius must have worked hand in hand to have accomplished these results, and the world has attained a higher degree of civilization by reason thereof.

"The officers of the association have deemed it advisable to omit the presentation of papers at this meeting on account of the meeting of the Electrical Congress at this time, feeling confident that the members would prefer to attend the meetings of the congress and the exposition.

"I wish to recommend at this time that the street and interurban railway companies of the Northwest be admitted to membership in this association. Many of the lighting plants are interested in street railway systems, or furnishing power for same. There is no street railway association in the Northwest at present, and should it be necessary to form an independent street railway association, many of our members would hesitate in attending both. I trust the members will thoroughly discuss this subject and act at this meeting in order that suitable papers can be secured for our January meeting, and that the street railway and power companies may present their applications for membership at that time."

The Annual Convention of the American Street Railway Association.

The twenty-third annual convention of the American Street Railway Association will be held October 12 and 13, 1904, on the second floor of the Transportation Building, Exposition Grounds, St. Louis, Mo.

Papers will be presented on such subjects as "Steam Turbines," "Reciprocating Engines," "Gas Engines," "Transfers, Their Uses and Abuses," and "Signals." The week of October 10 will be street railway week, the Mechanical association holding its meetings on October 10 and 11, and the Accountants' association on October 14 and 15. It is expected that a large number of street railway men will spend the week at the fair and attend the sessions of the different associations.

Wednesday, October 12, has been designated as Street Railway Day by the officials of the World's Fair. It is expected that addresses will be made by President D. R. Francis, Mayor Rolla Wells and Professor W. E. Goldsborough.

The manufacturers' committee has prepared a fine programme of entertainment for the visitors and delegates. There will be arrangements for a musical programme, giving a concert at the hall before the opening of each session, and numerous concerts during the week.

The officers of the American Street Railway Association are: president, W. Caryl Ely, Buffalo, N. Y.; first vice-president, Elwin C. Foster, New Orleans, La.; second vice-president, John Grant, St. Louis, Mo.; third vice-president, James F. Shaw, Boston, Mass.; secretary and treasurer, T. C. Pennington, 2020 State street, Chicago, Ill.

The Convention of the Independent Telephone Association of the United States.

The annual meeting of the Independent Telephone Association of theUnited States convened at St. Louis, September 21-27. The headquarters were held at the Inside Inn, situated within the fair grounds. Papers were read and discussed, and special entertainment arranged for the visitors and delegates.

The following programme was announced:

SEPTEMBER 21—10 A. M.

Reception to delegates, Inside Inn parlor.

Address of welcome. Hon. David R. Francis, president Louisiana Purchase Exposition.

President's annual address. Hon. Hugh Dougherty, president Independent Telephone Association of the United States.

"Electrical Features of the World's Fair." Professor W. E. Goldsborough, chief department of electricity, Louisiana Purchase Exposition.

"What Telephone Engineering Needs." Professor J. C. Kelsey, Purdue University, La Fayette, Ind.

"The Value of Organization." Jas. B. Hoge, Cleveland, Ohio.

The call of the states. Informal discussion.

SEPTEMBER 22—10 A. M.

"The Patent Situation." Edward E. Clement, Washington, D. C.

"Independent Finances." Frederick S. Dickson, president Federal Telephone Company, Cleveland, Ohio.

"Planting a Telephone System." Samuel G. McMeen, consulting telephone engineer, Chicago, Ill.

Address by C. E. Wilson, Keystone Telephone Company, Philadelphia, Pa.

General discussion, "Independent Telephony." This will be informal, and all independents are urged to be present and take part.

SEPTEMBER 23—10 A. M.

Report of secretary-treasurer, Frank G. Jones, Chicago, Ill.

Report of committees.

Election of officers and executive session.

A further report of this convention will be published next week.

THE NINTH ANNUAL CONVENTION OF THE INTERNATIONAL ASSOCIATION OF MUNICIPAL ELECTRICIANS.

ST. LOUIS, MO., SEPTEMBER 13 AND 14.

The ninth annual convention of the International Association of Municipal Electricians was held at the Grand View Fraternal Hotel, St. Louis, Mo., September 13 and 14, 1904. The meeting was called to order by President A. C. Farrand, of Atlantic City, N. J., who then made his address. In it he called attention to the large gathering of electrical engineers in St. Louis, and congratulated the association on its being present during the congress week. He also urged the members to greater efforts to extend the sphere of usefulness of the association. After the president's address and the reading of several letters of regret and the transaction of routine business, the association took up the reading and discussion of the papers.

Mr. Adam Bosch, of Newark, N. J., whose topic was the "Limitation of the Telephone for Fire-Alarm Purposes," took the ground that the telephone as an auxiliary to the fire-alarm telegraph was very valuable, but it was a mistake to rely too much upon the human equation, which entered into the transmission of signals by it. The time consumed in making connections and getting an intelligent answer from the excited citizen were much longer than that necessary to send a signal from a box. "I can not see how a telephone system could be devised to accomplish the sending of an alarm with anything approaching the automatic fire-alarm system in reliability."

In the discussion which followed the majority of the speakers agreed with Mr. Bosch.

Mr. Yeakle, of Baltimore, Md., took the ground that the use of the telephone as an auxiliary should be encouraged in every possible manner.

Mr. Murphy, of Cleveland, Ohio, rather favored the discouragement of the use of the telephone altogether, he holding that as many boxes as possible should be installed, and the public educated as to their use and location.

In the absence of the author, Mr. Wm. Thompson, of Richmond, Va., a paper entitled "The Inspection of Theatres from an Electrical Standpoint" was read by the secretary. Mr. Thompson called attention to the necessity of rigid inspection of the electrical equipment of theatres at all times, and in the discussion which followed it was brought out that the majority of road companies had improved their electrical equipment within the last year.

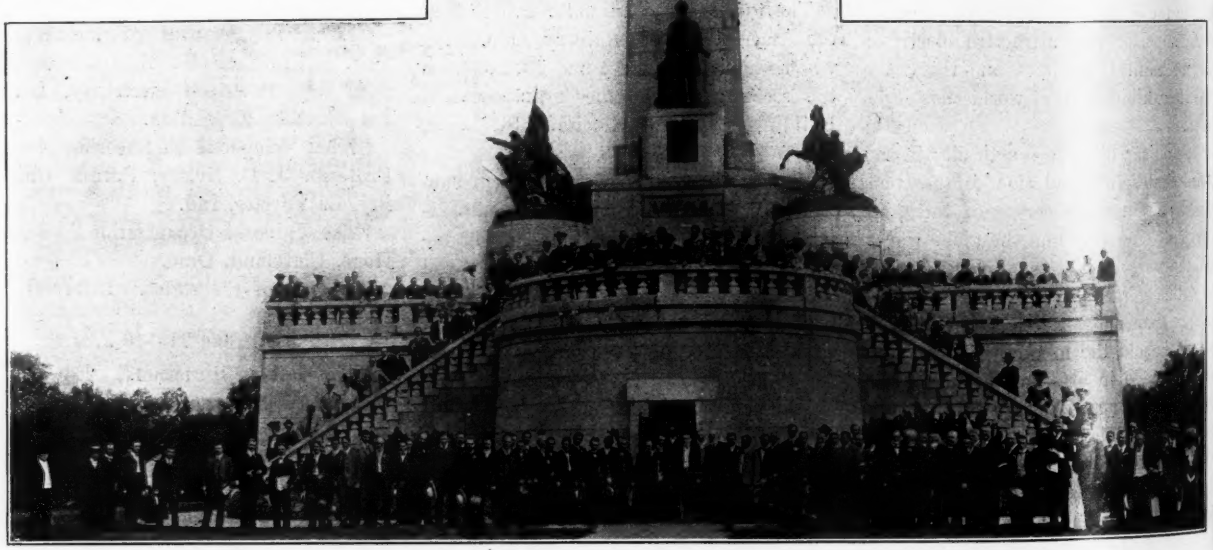
Mr. Foster, of Corning, N. Y., said that rules had been adopted in his city that gave him absolute authority to ring down a curtain if the equipment did not comply with the standard.

Mr. A. S. Hatch, of Detroit, Mich., read a paper on street lighting, he said:

"The principles involved in outdoor illumination are two, an even illumination of the section under consideration, and a brilliant illumination of the street intersections only. The first principle is the ideal lighting, since it more nearly approaches that of moonlight and gives a greatly improved police protection in lighting the alleys and yards, as well as the street corners, and is best accomplished by the tower system, although small lamps at frequent intervals on both sides of the street as a substitute for lighting the streets only on account of the numerous shade trees, are better."

Mr. Hatch showed drawings of special forms of switch used in Detroit and also a practical form of mast-arm for use on street corners. He also called attention to the many systems of street lighting in use and gave some valuable advice as to the best methods of lighting cities. He advises the municipalities to always consult a competent consulting electrical engineer before undertaking any work.

The discussion which followed was participated in by Messrs. Williams, Murphy,



THE PARTICIPANTS IN THE CIRCULAR TOUR UNDER THE AUSPICES OF THE AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS, AT LINCOLN'S TOMB, SPRINGFIELD, ILL., SEPTEMBER 11, 1904.

Bosch, Foster, Storer, Petty and others. The question box, which was one of the very valuable features of the convention of this association, was then taken up, some fifteen questions pertaining to municipal electrical engineering being asked and discussed.

Mr. W. M. Petty, of Rutherford, N. J., read a paper on "Methods of Testing."

The election of officers resulted as follows:

President, W. M. Petty, Rutherford, N. J.

First vice-president, J. B. Yeakle, Baltimore, Md.

Second vice-president, G. H. Holderman, Indianapolis, Ind.

Third vice-president, C. E. Diehl, Harrisburg, Pa.

Fourth vice-president, Chas. Greenald, New Brunswick, N. J.

Treasurer, G. F. MacDonald, Ottowa, Canada.

Secretary, F. P. Foster, Corning, N. Y.

Executive committee: J. Murphy, Cleveland, Ohio; Wm. Crane, Erie, Pa.; M. J. Donohue, Niagara Falls, N. Y.; A. S. Hatch, Detroit, Mich.; C. L. Williams, Laurel, Miss.; A. C. Farrand, Atlantic City, N. J.; W. H. Thompson, Richmond, Va.; F. C. Mason, Brooklyn, N. Y.; John S. Craig, Toronto, Canada.

Finance committee: W. H. Bradt, Troy, N. J.; Jas. Grant, New Haven, Ct.; T. C. O'Hearn, Cambridge, Mass.; J. D. Hall, Peoria, Ill.

Erie, Pa., was selected as the place of next meeting. Thursday morning the association met in joint session in section "G" of the International Electrical Congress at the Coliseum, St. Louis.

The local superintendent of fire and police, Mr. T. F. Almon, showed the members many courtesies and kindnesses, which were much appreciated.

The Visiting Delegates.

One of the most interesting excursions which a number of the visiting delegates en route to St. Louis to participate in the International Electrical Congress undertook was the visit by the members of the Associazione Elettrotecnica Italiana, to the establishment of the Crocker-Wheeler Company, at Ampere, N. J.

The party was in charge of Mr. John W. Lieb, Jr., president-elect of the American Institute of Electrical Engineers and chairman of the general reception committee. At the Crocker-Wheeler Company's headquarters the party was received by Gano S. Dunn, vice-president of the Crocker-Wheeler Company; W. S. Brownell, treasurer; H. C. Petty, manager contract department, and H. W. Patterson, Newark, N. J.

After luncheon the visitors were divided into parties of five, each party in charge of a guide and shown through the works. Upon reassembling the entire party a photograph was made, which, through the courtesy of Mr. Gano S. Dunn, is reproduced herewith.

Another interesting feature of the circular tour held under the auspices of the American Institute of Electrical Engineers, was the visit of the participants to Lincoln's tomb at Springfield, Ill. After leaving Chicago on the evening of September 10, the train reached Springfield 7.30 on the morning of September 11. After breakfast, a trollev trip was made to Lincoln's tomb, the delegates and visitors showing a keen interest in recalling the history of the great emancipator who is memoralized by this monument. Shortly before leaving on the return trip to Springfield, where the train was boarded for St. Louis, a photograph was made, a reproduction of which is shown on the page opposite.

THE ASSOCIAZIONE ELETTROTECNICA ITALIANA AS GUESTS OF THE CROCKER-WHEELER COMPANY, AMPERE, N. J., AUGUST 31, 1904.

THE CONVENTION OF THE NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION.

SEPTEMBER 14, 15 AND 16, ST. LOUIS, MO.

On the books of the National Electrical Contractors' Association, the registration showed an attendance of nearly four hundred at the fourth annual convention of the National Electrical Contractors' Association, held in the Century Building, St. Louis, September 14, 15 and 16. This included a party of ladies and guests of the association.

On Wednesday, September 14, a little after 10 A. M., the first session of the board of directors was called to order in the Century Building. In the afternoon at 2 P. M., the general convention was called to order and an address of welcome was delivered by the mayor of St. Louis, Hon. Rolla Wells, which was gracefully responded to by the president of the association, E. McCleary, of Detroit. On the following day, September 15, the general business session of the meeting was held a little after 10 A. M. This meeting, as well as the previous ones, was held behind closed doors, and in courtesy to the association the ELECTRICAL REVIEW omits all comment on the proceedings of these meetings.

By a decision made the previous day the meeting of Friday, September 16, was an open one, to which electrical manufacturers, electrical supply dealers and representatives of the technical press were invited. At this meeting, perhaps, the

most important discussion was on the subject of state licensing for electrical contractors. Messrs. Eidlitz, Gray, Galloway and Kneider presented the advantages of such a procedure and the question was carefully analyzed in its several aspects. It is a matter of interest to know that the state of Minnesota, as well as the cities of Washington, D. C., and Denver, Col., has such a system.

G. W. Sanborn, Indianapolis, chairman of the Underwriters' committee, was called upon and discussed developments bearing on the Underwriters' rulings.

W. S. Sisson, of the D. & W. Fuse Company, Providence, was asked to make clear several points as to fuse construction and to speak on the matter of the adoption of the new type of knife blade fuse. In response to this instruction, Mr. Sisson said his company preferred to hold to the improved type "A" fuse, but that his company would furnish the new type at the request of the Underwriters.

W. W. Low, of Chicago, president of the Electrical Supply Dealers' Association, spoke as to the sympathy and interest which should exist between the supply dealers and contractors.

C. E. Flack, of the American Conduit Manufacturing Company, Pittsburg, was asked to explain the method of construction in its armored conduits.

Stephen H. Goddard, of the ELECTRICAL REVIEW, complimented the association on the decision for an open meeting each year as overcoming the idea that the meetings of this body were "star chamber" affairs. He also called attention to the fact that the technical press was in good part responsible for the large attendance at these meetings.

C. E. Lee, of the Electric Gas Light Company, Boston, made a brief explanation as to the methods of his company in protecting electrical contractors in making sales. At the close of Mr. Lee's remarks his company was heartily commended by the association for its attitude and the individual members of the association were asked to favor this company in their patronage.

Mr. H. B. Coho, of the Keystone Electric Company, Erie, Pa., addressed the association on the advantages of contractors following more universally the practice of making their own installations of electrical machinery.

Alex. Henderson, of New York, master of transportation, then announced that a special train with Pullman equipment would leave New York city at 5 P. M. the night previous to carry members of the association to attend the next convention of the National Electrical Contractors' Association to be held at Boston, the third Wednesday in July, 1905.

At the conclusion of this announcement a motion was introduced, and seconded, thanking Mr. Henderson for his most satisfactory execution of the duties of his office.

At the adjournment of this final meeting the board of directors met, and the following officers were elected. It will be observed that all the officers of last year were reelected with the exception of slight changes in the board of directors.

Mr. E. McCleary, 213 Jefferson avenue, Detroit, Mich., president.

Mr. W. I. Gray, 804 Sykes Block, Minneapolis, Minn., first vice-president.

Mr. Walter C. McIntire, 506 Commerce street, Philadelphia, Pa., second vice-president.

Mr. J. P. Coghlin, P. O. Box 884, Worcester, Mass., third vice-president.

Mr. John R. Galloway, 529 G street, N. W., Washington, D. C., treasurer.

Mr. W. H. Morton, 44 Whitesboro street, Utica, N. Y., secretary.

Mr. J. C. Sterns, 255 Pearl street, Buffalo, N. Y., sergeant-at-arms.

THE BOARD OF DIRECTORS.

New York—James R. Strong, 35 South William street, New York; M. L. Barnes, 273 River street, Troy.

Pennsylvania—E. R. Keller, Philadelphia.

Michigan—F. J. Miner, 207 Jefferson avenue, Detroit.

Minnesota—E. A. Richardson, Minneapolis.

Maryland—H. K. McKay, Baltimore.

Missouri—F. E. Adam, St. Louis.

THE NATIONAL ELECTRICAL CONTRACTORS' ASSOCIATION, ST. LOUIS, SEPTEMBER 15, 1904.

Indiana—G. M. Sanborn, Indianapolis.

Washington, D. C.—E. C. Graham.

Ohio—E. M. Lawton, Cincinnati.

Illinois—Arthur Frentzen, Chicago.

Connecticut—H. E. Page, Hartford.

Massachusetts—Seth B. Witherbee, Boston.

Wisconsin—George C. Rohn.

Iowa—Edward Kunkel, Des Moines.

Arkansas—T. B. Martin, Jr., Little Rock.

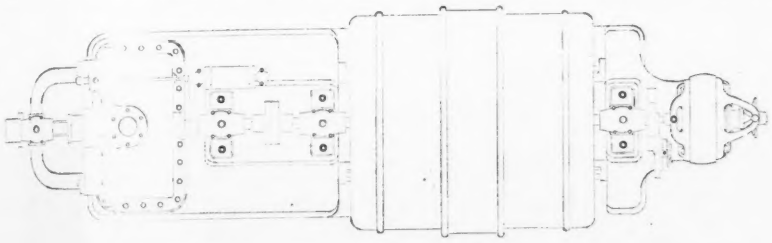
The members of the association and guests were entertained by the local committee at a banquet given at Blanke's German restaurant on the "Pike" at the exposition grounds in the evening at eight o'clock. At this dinner a loving cup was presented to Mr. Charles L. Eidlitz, of New York.

THE STEAM TURBINE AND ITS USE.[1]

BY E. C. CROCKER.

The value of the steam turbine is based not only on its efficiency, but also on the first cost as compared with the engine to do a like service, the minimum amount of floor space required, light foundations, the minimum amount of attention and the simplicity of its operation.

The turbine which I shall describe is built on the principle of expanding steam in a diverging nozzle down to a given pressure, where it impinges on the first set of blades or buckets fastened to a revolving disc. It is then received by a stationary set of guides which further expands the steam and directs the flow on

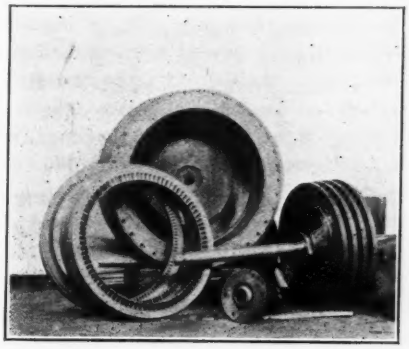


PLAN OF CROCKER STEAM TURBINE.

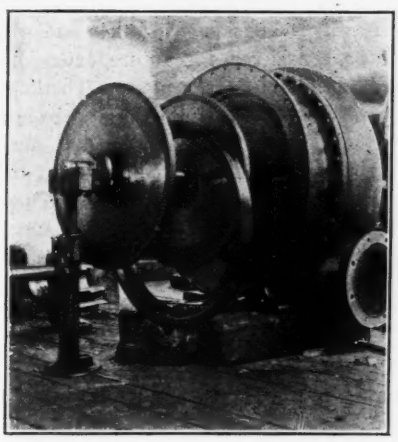
to a second set of blades or buckets fastened to a second revolving disc, and so on successively until the steam is delivered to the exhaust in nearly a stationary condition.

After a number of experiments on making nozzles to get as nearly a true expansion as possible following the curve line of the steam, I decided that the best method was to cast a solid bronze ring and cut the diverging nozzles out of the face of this ring, which by so doing, instead of giving a nozzle with straight walls, gives one, while following the expansion of steam, at the same time follows the circle of the ring, thereby following very nearly the natural curve line of expanding steam. An automatic machine has been made for cutting these nozzles, and after this operation has been made and the ring turned off, another solid bronze ring is shrunk on to the outside, thereby closing up the side of the nozzle and making it complete. This nozzle ring is then set into a circular steam chamber, forming one of the walls of said chamber, and it is so arranged that when the steam discharges it blows on to the buckets arranged around a circular disc, and as these nozzles follow each other around the complete circle, the entire set of buckets is filled with steam when the turbine is working at its maximum load. An automatic arrangement is provided, whereby one or more nozzles are automatically cut in or out, as any variation of the load may require, thereby giving the turbine an efficiency at part load which is very nearly equal to the full-load efficiency. By this method of control the steam is never throttled, except on the nozzle that the governor is operating on, the rest of the nozzles being either entirely closed or doing a maximum amount of work. It is very essential to get the correct shape of nozzles in order to get the highest degree of efficiency from the turbine, and it is also essential that the buckets and guide vanes should be made of the proper radius and angle, and they should be so proportioned that the reaction of the steam shall counterbalance the end thrust due to the difference of pressure between the first set of buckets and the exhaust end of turbine. These should be so proportioned that there should be a slight amount of thrust, which a good thrust bearing can easily take care of.

The speed of the turbine is regulated by a centrifugal governor which forces a pin against a cut-off valve connected to the exhaust chambers of a small steam cylinder. This cylinder has a piston which is directly connected to a cut-off ring inside of the steam chest of the turbine. This cut-off ring is held against the face of the inlet side of the nozzle and has holes in it of different lengths, whereby any movement of the cylinder cuts in or out certain nozzles according to the direction of the movement of the piston. So close a regulation is secured by this method that two per cent is guaranteed, and it can be controlled so that it may operate with two to six per cent, as the conditions under which the turbine is to operate may require. This cut-off ring, however, is only used on the smaller-sized turbines from 100 to 300-kilowatt capacity; on the larger sizes the steam enters a governing receiver which acts in the same manner. This receiver has a hollow balanced port valve. This port valve controls the opening to different sections of the steam chest of the turbine, and one or more openings are made or closed according to the load in the same manner as on the smaller turbines. The whole turbine is complete in every detail, being mounted on an iron subbase, has a pump for forcing lubrication through all the bearings, no oil being used in connection with the internal parts of the turbine, and allows the use of the condensed steam direct to the boilers, without the use of separator. The possibility of the outfit getting out of order is as remote as the best mechanical art and the present knowledge of steam turbine practice can remove them. Every central station manager will appreciate the small wearing parts and that no cylinder oil has to be used; the oil used in the bearings returns again to the pump and is used over and over again, very little being wasted. The buckets of this turbine are made of drop-forged steel and dovetailed into steel discs, the whole being finished by grinding before it is assembled. In fact, the highest grade of work enters into the turbine through its entire construction.



CASE OF TURBINE, WITH DISCS AND GUIDES READY TO ASSEMBLE.



PART OF DISCS AND GUIDES SLIPPED OUT OF CASE ON THE SHAFT.

The development of the steam turbine in the last twenty-five years is due more

[1] Paper read before the Ohio Electric Light Association, Sandusky, Ohio, August 17.

to the development of the electric light and power work than anything else, though the advantage of steam turbines for driving rotary pumps is appreciated by builders of this type of apparatus. The development of the electric stations has been wholly within the period of the past twenty-five years, and the value of a direct coupling of dynamo to its source of power is well recognized. The dynamo is essentially a high-speed machine, and the attempts to couple direct or reciprocating engines has developed a dynamo, the size of which is far in excess of that required by good economy and low cost of maintenance. To operate a dynamo at low speed it must be either at the expense of efficiency or an excessive increase of material in its construction. The reciprocating engine, on the other hand, is essentially a slow-speed machine, and bringing the two successfully together has been a very costly practice. The combination of the steam turbine and the dynamo is the solution of a good many difficult problems in engineering, the result of which is a unit, the value of which for central station work is, I believe, already recognized by the majority of engineers throughout the country, and is destined to become the power-producer for all electric stations where steam is used. I am not one of those who believe that the steam turbine will relegate the reciprocating engine to the scrap heap, as I believe that each type has its own field, but I do believe that for electric power the reciprocating engine within the next few years will be considered obsolete and will not be considered for future extensions by producers of electric power. The huge generating plants of the past I believe will not be considered, as the public come to thoroughly understand the value of the turbine in its practical operation. There have been three distinct types of steam turbines commercially developed, one depending on extremely high bucket velocity, using a single wheel. In another the bucket velocity is reduced by using a large number of buckets and guides on a cylinder transforming the steam into velocity as it flows through the successive number of guides. The last, and what I consider the best, and on the lines of which I believe the steam turbine of the future will be developed, is the one described in this paper. Each successive set of bucket wheels, bearing buckets of increased size, each wheel in turn extracting a part of the velocity of the steam, and by the increasing size of each set of buckets providing for the increased volume of the steam.

The turbine developed by me, in which I use the form of nozzle and buckets described, has given very gratifying results. The Warren Electric Manufacturing Company has acquired the sole right to manufacture this turbine, and is now building them with very gratifying success.

The use of the steam turbine is practically confined to the direct connection of electric generators, though some are used and a great many more will be used in the future for direct coupling to rotary pumps, or wherever a direct application of power to a shaft of high rotative speed is desirable.

To get the highest economy from the steam turbine it is necessary to run condensing, and as high a vacuum as possible should be secured, though they may run non-condensing with practically the same results as can be got from a reciprocating engine.

Telegraph vs. Telephone.

[*Boston Transcript, September 12.*]

Is the telegraph doomed? This somewhat surprising question is raised by some suggestive figures which appear in a recent issue of the ELECTRICAL REVIEW regarding the comparative growth of the telegraph service of the world and the use of the telephone. The telegraph is much older than the telephone, yet in this country the latter is used fifty times where the telegraph is used once, and statistics show that the use of the telegraph is not extending. Figures for the telegraph service show that in 1903, nearly 365,000,000 messages were sent in all countries, an average of about a million messages a day. Great Britain is credited with the sending of 92,471,000 messages, and the United States comes second with 91,391,000 messages. In 1902, for which the telephone statistics are available, the number of messages transmitted in the United States alone was more than 5,000,000,000. The business has increased tremendously since then, while British postal statistics show that in 1903 there was a falling off in the number of telegrams sent in the United Kingdom of 2.7 per cent from the previous year.

There can be no question that the diminution of the use of the telegraph is almost wholly due to the increasing competition of the telephone. The REVIEW attributes it in part to the great industrial combinations. The greater convenience of the telephone, however, would make it a formidable competitor of the telegraph under any conditions. The installation of private and house telephone systems in every large business establishment, the increasing number of telephone companies and the building of lines into the rural sections, have contributed to make the telephone almost universal, and there is very little increased building of telegraph lines, these generally following the direct lines of communication between business centres. In the development of wireless telegraphy and with wireless telephony expected in the near future it seems not unreasonable to expect that the telegraph will suffer from a still greater competition, and that its use will be more and more restricted. It will be a long time, however, before the telegraph lines of the country will be given up. The telegraph serves an important use, and has some advantages over other methods of communication which will continue to give it a long life.

The proposal of the New England Telephone and Telegraph Company to put in a farmers' telephone line from Millbury to outlying farms and hamlets moves the Worcester *Gazette* to a consideration of the rapidly growing extension of the business. "There are already," it says, "numerous suburban and country lines in existence about Worcester, but it appears that there is still plenty of room for more. There will be room as long as a single household remains without this most convenient modern method of communication." The history of development in the telephone service has been the history of all large inventions. It started with the few who could afford luxuries in their business and now in the fulness of time it is getting down to those of more moderate resources, not as a luxury but as one of the up-to-date conveniences of life. When the mowing machine was first put on the market only fancy farmers used it, but now it is as common as the wagon that hauls the crop to the barn. Now that the telephone has come within reach of the farmer it meets needs that were formerly hardly suspected. No class can find a more general use for it. It breaks the isolation that has been so deadening an influence in scattered communities. It is a great industrial convenience and a stimulator of social intercourse. It makes men more intelligent and public-spirited citizens. We very much doubt whether Mr. Folk would be to-day the nominee for governor of Missouri had it not been for the active working of the rural telephone throughout the state, which enabled the farmers to keep constantly informed of the operations of the machine and organize to defeat them. It makes of the back townsman an individual and independent force, not a mere unit to be herded with others of his kind at the pleasure of the bosses.

The Production of Graphite in 1903.

The importance of the graphite industry in the United States becomes apparent when one considers the quantity of graphite annually consumed in this country, the amount produced here, and the annual importation. In 1903, the United States consumed 37,758 short tons of graphite, valued at $1,598,589. The value of the total home production was only $225,554. Although this is an increase of $43,446 in value over the production of 1902, which had a value of $182,108, it represents very much less than the quantity of graphite required to meet the demand. The annual importation of graphite into the United States each year far exceeds, therefore, the domestic production. The value of the imports in 1903 was $1,207,730, against $1,168,554, the value of the graphite imported in 1902. These figures are taken from a report entitled, "The Production of Graphite in 1903," which Dr. Joseph Hyde Pratt has made to the United States Geological Survey. It is published as an extract from the forthcoming volume on "Mineral Resources of the United States, 1903," and may be obtained without charge from the director of the United States Geological Survey, Washington, D. C.

Three distinct varieties of graphite are on the market—crystalline, amorphous, and artificial. Of the two natural forms of graphite the crystalline is the more valuable, and is usually a purer grade of graphite. It is worth about $70 a ton, whereas the amorphous variety brings only about $15 a ton. The artificial graphite sells for about $92 a ton, its high value being due to the particular form in which some of it is produced.

Crystalline graphite can be used for all purposes for which graphite is required, but is employed chiefly in the manufacture of refractory products, lubricants, electrotypes, and pencils, for which it is especially adapted on account of its purity. The bulk of the world's supply of crystalline graphite is procured from the island of Ceylon. In the United States crystalline graphite is obtained principally from Essex and Washington counties, N. Y., and from Chester County, Pa., but small amounts are mined in Coosa and Clay counties, Ala. In Colfax County, N. Mex., and Albany County, Wyo., are deposits of graphite, varying from semi-crystalline to crystalline, that are being developed and mined to a limited extent.

The production of crystalline graphite in the United States during 1903 amounted to 4,538,155 pounds, valued at $154,170, which is an increase of 601,331 pounds in quantity and of $28,026 in value compared with the production of 3,936,824 pounds, valued at $126,144, in 1902. The increase would have been larger if the mill of the Federal Graphite Company in Chester County, Pa., had not been destroyed by fire early in 1903. The states that produced this crystalline graphite are New York, Alabama, Pennsylvania, New Mexico, and Wyoming.

Occurrences of amorphous graphite are much more abundant than those of the crystalline variety, but on account of the difficulty experienced in refining the crude ore, many of these deposits are not now of commercial value. The greater part of the world's supply of amorphous graphite is obtained from Austria-Hungary. In the United States supplies of this variety of graphite are obtained principally from Providence County, R. I., and Baraga County, Mich., but small amounts are mined in Sonoma County, Cal.; Barton County, Ga.; Wake County, N. C.; Lawrence and Pennington counties, S. Dak.; Portage County, Wis.; and Ormsby County, Nev. A new deposit of graphite has recently been reported three miles east of Bossburg, Wash., but little work has yet been done to determine the extent of the deposit.

The production of amorphous graphite showed a large increase in 1903. It amounted to 16,591 short tons, valued at $71,384, or $4.30 a ton, an increase of 11,852 tons in quantity and of $15,420 in value, as compared with the production of 4,739 short tons, valued at $55,964, or $11.81 a ton, in 1902. This large increase is due to the development of the Georgia deposits, the product of which was put on the market in large quantity, but at a very low price. The states which contributed to the production of amorphous graphite in 1903 were Georgia, Wisconsin, Michigan, Rhode Island, South Dakota, California, Nevada, and North Carolina.

The three principal methods by which artificial graphite has been made are described by Dr. Pratt, who places special emphasis on the now famous Atcheson process. Since artificial graphite was first put on the market in 1897, there has been an almost constant increase in its production. The quantity of this variety of graphite that was manufactured in 1903 amounted to 2,620,000 pounds (the largest quantity produced in any year), valued at $178,670. When this value is compared with the value ($235,154) of the natural graphite produced in 1903, which is only $46,484 greater, it is seen at once that artificial graphite occupies a very important place in the industry.

The Convention of the Society for Promotion of Engineering Education.

The annual meeting of the Society for the Promotion of Engineering Education was held in the Palace of Education at the World's Fair, St. Louis, on September 1, 2 and 3. The meeting was conducted by President C. Frank Allen, of the Massachusetts Institute of Technology. His address was entitled "The Outlook for Engineering Education."

President Alex. C. Humphreys, of the Stevens Institute of Technology, presented a paper on "The Crowding of the Curriculum," which provoked considerable discussion. Professor Arthur N. Talbot, of the University of Illinois, read a paper on "Cooperation in Engineering Investigation."

Professor John G. D. Mack described the system of arranging and indexing industrial college items at the University of Wisconsin. The paper of Professor Ira N. Hollis, of Harvard, on "Technical Education at the Naval Academy" provoked much comment; the majority taking part in the discussion being opposed to the method of separating classes into sections with the idea of segregating students less apt and not impeding the progress of brighter ones.

"Field Work in Civil Engineering at Iowa State College" was read by professor of civil engineering A. Marston.

Professor Alfred E. Burton, Massachusetts Institute of Technology, talked informally on the work of the dean of the faculty of the Massachusetts Institute of Technology. The dean serves as a go-between the students and faculty and the experience of the last two years has been very satisfactory, many students taking advantage of the privilege of consulting him.

Professor Edward R. Maurer, University of Wisconsin, presented a paper on "Absolute and Gravitation Systems of Dynamic Units." The teaching of calculus to engineering students was treated by both Professors Albert M. Kenyon, Purdue University, and Benjamin F. Groat, University of Minnesota.

In the selection of officers, Frederick W. McNair, Michigan College of Mines, was elected president; Elwood Mead, United States Department of Agriculture and University of California, C. R. Jones, West Virginia University, vice-presidents; M. S. Ketchum, of the American Bridge Company, secretary; Frederick E. Spalding, University of Missouri, treasurer; Thomas Gray, Rose Polytechnic Institute, C. H. Waldo, Purdue University, A. N. Talbot, University of Illinois, James C. Nagle, Agricultural and Mechanical College of Texas, W. G. Raymond, Iowa State University, L. E. Reber, Pennsylvania State College, and Robert S. Woodward, Columbia University, members of council.

TRANSFORMER TESTING FOR CENTRAL STATIONS—II.[1]

BY S. E. JOHANNESON.

IMPEDANCE.

The impedance in alternating-current circuits is analogous to the resistance in direct-current circuits. The impedance drop of a transformer is the volts required to force full-load current through one of its windings with the other short-circuited.

$$\text{Current} = \frac{\text{Volts}}{\text{Impedance.}}$$

The impedance is made up of two components at right angles to each other. (Reactance and resistance.) Impedance and reactance may be expressed in equivalent ohms. Impedance drop and reactance drop may be expressed directly in volts or in percentage of full-load voltage.

The impedance drop is usually measured on the high-tension side in standard transformers, since its values measured on that side are well within the range of commercial measuring instruments. The current for any transformers may be determined by the formula:

$$\text{Current} = \frac{\text{Capacity of transformers in watts}}{\text{Rated high-tension voltage.}}$$

The impedance volts expressed in per cent of normal rated voltage of standard lighting transformers will range between two per cent and six per cent. Approximate values are as follows:

25-cycle transformers, impedance volts = 3%
60 " " " " = 5%

The impedance varies directly with the current. If, therefore, the instruments and governing apparatus will not handle full-load current, it may be measured at any other current value and readily calculated.

Procedure of Tests—Connect as shown in Fig. 8. Close switch. Adjust resistance until required current flows through windings of transformers. Read simultaneously current and voltage values.

The ammeter may be placed in either the primary or secondary side of the transformer, the primary being considered as the side to which the power is applied. Since the reactance varies directly with the frequency, the latter should be known.

Errors introduced are practically the same as those discussed under resistance. Necessity for correction will depend on the magnitude of error and the accuracy required.

The transformer should be short-circuited through its own terminals and the connection should be carefully made. If terminals are too short to connect together, the conductor introduced should be of a section preferably greater than that of the terminals.

Example—Measure impedance of a fifty-kilowatt, 1,000, 2,000/100, 200-volt, sixty-cycle transformer. Assume for trial that the impedance is four per cent. If measurements are to be made on secondary side the current and voltage values will be 250 amperes and approximately eight volts. If measurements are made on the primary the values will be twenty-five amperes and approximately eighty volts. The primary values to be measured are well within range of station instruments.

Suppose the impedance drop actually obtained in test to be eighty-eight volts, the per cent impedance drop $= \frac{88}{2000} = .044 = 4.4$, and the equivalent impedance ohms $= \frac{88}{25} = 3.52$.

REACTANCE.

The reaction drop $= \sqrt{\text{per cent imp. drop}^2 - \text{resist. drop}^2}$.

CORE LOSS AND EXCITING CURRENTS.

In the operation of transformers, two distinct losses take place; one the core loss and the other copper loss.

The core loss includes the hysteretic and eddy current losses. The hysteretic loss is due to magnetic friction and the eddy current loss is due to currents generated in the laminations.

Core loss, generally speaking, is both a constant and continuous loss. It occurs when a transformer is magnetized, whether running idle or delivering power. Transformers are usually connected permanently to the generator circuit and, in the majority of plants, these circuits are continuously charged.

The economical operation of a lighting plant depends in a large measure on the selection of an economical transformer. An economical transformer is seldom the one of lowest first cost, nor is it necessarily the one having the smallest full-load losses. It is the transformer which has the most suitable division of losses for the service for which it is to be used.

Of the several methods in use for determining core loss, the one given below is easiest to apply and gives very accurate results.

Determine values for selection of instruments as follows:

The core loss should be measured on the low-tension side of transformer. The rated low-tension pressure determines size of voltmeter.

The core loss or true watts is usually given in performance tables. The apparent watts (exciting current + volts applied) is greater than the true watts and are approximately as follows:

25-cycle trans. apparent watts = 3½ times watts
60 " " " " = 1⅔ " "
133 " " " " = 1¼ " "

The exciting current is the apparent watts divided by voltage at which transformer is tested.

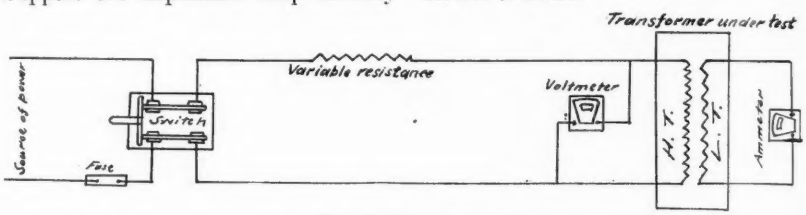


FIG. 8.—IMPEDANCE.

The current capacity of wattmeter should not be less than the exciting current.

In applying low-frequency currents to transformers, momentary rushes of current sometimes takes place during switching. Therefore when testing core loss and exciting current with low-frequency currents the ammeter and series coil of wattmeter should be short-circuited through an auxiliary switch when main switch is being operated.

Procedure of Tests—Connect as shown in figures with all instruments in circuit. Close switch, adjust pressure to rated low-tension voltage of transformer. If wattmeter reading is negative, interchange pressure leads on wattmeters not provided with reversing switch. Observe all instruments simultaneously. Record values. Frequency of current should be known.

Since the hysteresis loss varies as the 1.6 power and the eddy loss as the square of the induction for the same frequency it is important that measurements be made at exactly the rated voltage.

The core loss decreases slightly as the temperature increases, but since there are no commercial means for determining the rate of decrease, correction for temperature can not be made. Core loss measurements should preferably be taken at twenty-five degrees centigrade.

The electromotive force wave form of

[1] Paper read at the tenth annual convention of the Ohio Electric Light Association, Sandusky, Ohio, August 16.

current employed in test also affects the magnitude of the core loss. A flat top wave will give a greater loss than a sharp peaked wave. A variation in core loss of five per cent to ten per cent in the same transformer is easily obtained by testing with currents having different electromotive force wave forms.

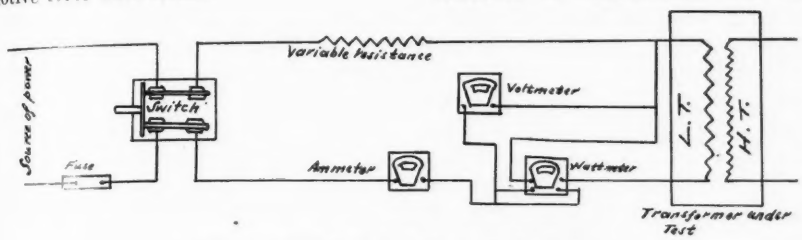


FIG. 9.—CORE LOSS AND EXCITING CURRENT.

By introducing ohmic resistance in alternating-current circuits the electromotive force and current wave forms are distorted (the current wave becoming more sinusoidal and electromotive force wave more peaked), the effect of these distortions being to reduce the exciting current and core loss. Therefore, whenever possible, voltage adjustment for core loss measurements should be made at generator, by varying excitation.

MAGNETIZING CURRENT.

The exciting current of a transformer is made up of two component currents at right angles to each other, the core loss and magnetizing currents.

The core loss current is found by dividing the watt loss by the voltage at which it is measured.

The magnetizing current =

$$\sqrt{\text{exciting current}^2 - \text{core loss current}^2}.$$

COPPER LOSS.

Copper loss takes place only when transformer is delivering power. The major part of this loss is due to the resistance of the windings and the current flowing through them and the minor part to the eddies produced in the windings by the leakage magnetic flux which cuts them.

The copper loss of a transformer varies as the square of the current flowing. It may be calculated from resistance of conductors and currents flowing through them as follows:

Copper loss in watts =

Prim. $\text{Amp.}_2 \times$ Prim. Resist. + Sec. $\text{Amp.}^2 \times$ Sec. Resist.

The copper loss may be measured simultaneously with the impedance drop by introducing a wattmeter into test circuit as shown in Fig. 10.

Selection of Instruments—The voltmeter and ammeter may be selected as explained under impedance tests. The wattmeter must be selected as to current, pressure and power. The latter may be determined by the copper loss of transformer under test.

Procedure of test is the same as in iron loss test except that instead of adjusting for a given voltage, adjust for a given current.

The results obtained include besides the copper loss, a small iron loss corresponding to pressure applied, and eddy current loss in the copper.

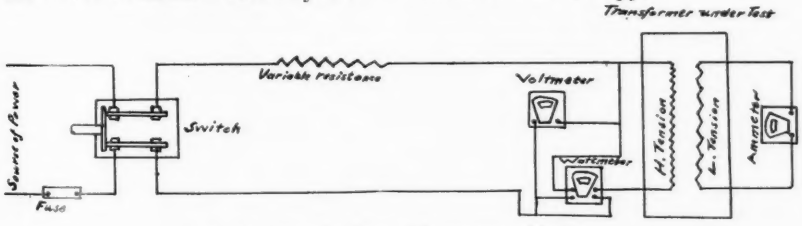


FIG. 10.—COPPER LOSS, WATTMETER METHOD.

Copper loss should also be corrected to twenty-five degrees centigrade, standard temperature. In both methods it is necessary to calculate correction direct from resistance values at twenty-five degrees centigrade. Resistance correction is explained under resistance test.

REGULATION.

The quality of service of a transformer is measured by its regulation. The success of a station largely depends on this qualification.

The regulation of a transformer is the ratio of the rise of secondary terminal voltage from full load to no load (at constant primary impressed terminal voltage) to the secondary terminal voltage. The regulation of the transformer may be measured by applying the actual load, and noting the rise of voltage when the load is thrown off. It is usually expressed in per cent of full-load voltage. In practice it is very difficult to obtain reliable results, owing to variation in voltage which is common in commercial alternating-lighting circuits, and also due to the very small difference in voltage which is to be measured.

The elements which affect the regulation of transformers are the resistance drop, reactance drop and the magnetizing component of the exciting current. For ordinary practice the regulation for non-inductive load may be calculated as follows: per cent regulation = per cent copper loss + $\frac{\text{per cent reactance drop}}{200}$.

More accurate values for non-inductive load regulation, also inductive load regulation may be obtained by Bedell's formulas given below:

FOR NON-INDUCTIVE LOAD.

$$\text{per cent regulation} = \frac{Rc + x^2 + 2\,x\,m}{200} \quad 1$$

Where X is the per cent reactance drop, R c the per cent resistance drop and m the per cent magnetizing component

$$x = \sqrt{\text{per cent imped. drop}^2 - \text{per cent resist. drop}^2} \quad 2$$

$$m = \sqrt{\text{per cent exciting current}^2 - \text{per cent iron loss current}^2} \quad 3$$

The iron-loss current is the watts iron loss divided by the voltage at which it is measured.

Example—Determine the regulation (non-inductive load) of a transformer with the following characteristics:

Impedance drop.... = 4 per cent
Resistance drop.... = 2 "
Exciting current.... = 4 "
Iron loss current... = 2.8 "

By substituting values of exciting and iron-loss currents in formula 3, $m = 2.86$ per cent, and by substituting values of per cent impedance and resistance drop in formula 2, $x = 3.47$ per cent.

Then by formula 1:

per cent regulation =

$$2 + \frac{3.47^2 + 2 \times 3.47 \times 2.86}{200} = 2.16$$

For Inductive Load—

$$\text{Per cent regulation} = x \sin \Phi + R\,c \cos \Phi \quad 4$$

Where x is the per cent reactance drop, R c per cent resistance drop and Φ the angle of lag of load delivered.

Example—Find inductive regulation for the above transformer when delivering a load to a circuit having P. F. of 0.87.

The angle having cos of 0.87 is thirty degrees. Its sin is 0.5. Substituting the proper values in formula 44. Per cent

regulation = 3.47 × 0.5 + 2 × 0.87 = 3.48.

The regulation is usually referred to the standard temperature of twenty-five degrees centigrade.

EFFICIENCY.

Efficiency is the ratio of the output to the input.

The output is the total useful energy delivered by the secondary and the input considered is approximately the total energy delivered to the primary and consists of the output energy plus the iron loss at the rated pressure and frequency plus the copper loss due to the load delivered.

There is also another loss, that due to the magnetizing component of the exciting current, but since this is in quadrature to the output current its effect is inappreciable in amount and may be neglected.

The copper loss employed in determining efficiency should preferably be calculated from the resistance. It is sufficiently accurate, however, to use the measured values as explained under copper loss tests.

Example—Find the full load and one-half load efficiency of a three-kilowatt, 2,000 to 100 or 200-volt, sixty-cycle transformer having an iron loss of fifty-seven watts, a primary resistance of fifteen ohms, a secondary resistance of 0.15 ohms.

The rated primary current of the above transformer is 1.5 amperes at 2,000 volts, and the rated secondary current is fifteen amperes at 200 volts.

Full load—

Primary	C^2R =	33.75 watts.
Secondary	" =	33.75 "
Core loss	=	57 "
Total		124.5 watts.

Output = 3000 watts; input = 3000 + 124.5 = 3124.5; full load eff. = $\frac{3000}{3124.5}$ = .9602 = 96.02 per cent.

Half load—

Primary	C^2R =	8.44 watts.
Secondary	" =	8.44 "
Core loss	=	57.00 "
Total		73.88 watts.

Output = 1500 watts; input = 1500 + 73.88 = 1573.9 watts. One-half load eff. = 1500 — .953 — 95.3 per cent.

The approximate efficiency may be readily calculated by multiplying full load losses expressed in per cent of the output, by coefficients below and subtracting their sum from 100.

Per Cent Load.	Copper Loss Coefficient.	Core Loss Coefficient.
150	1.5	0.66
125	1.25	0.8
100	1.0	1.0
75	0.75	1.33
50	0.5	2.00
25	0.25	4.00

Find approximate efficiency at one-half load in example above.

The per cent copper losses based on output of 3,000 watts is 2.25 per cent; core loss, 1.9.

For one-half load:

Per cent copper loss = .5 × 2.25 = 1.13; per cent core loss — 2 × 1.9 — 3.8; total loss, 4.93.

Per cent efficiency load = 100 — 4.93 = 95.07, say 95.1.

More accurate values of efficiency may be obtained as follows:

Subtract from the per cent loss (obtained by the use of coefficient) the one-hundredth part of that loss squared. Then subtract from 100. Thus:

$$\frac{493^2}{100} = .243$$

then 4.93 = .24 — 4.69, say 4.7.

Per cent efficiency one-half load = 100 ÷ 4.7 = 95.3.

The differential quantity may be mentally calculated by leaving off the fractional part of per cent loss and taking nearest whole number, thus:

$$\frac{5^2}{100} = .25$$

4.93 ÷ .25 = 4.68, say 4.7; per cent eff. at one-half load = 100 ÷ 4.7 — 95.3

The *all-day efficiency* of a transformer is the ratio of the output to the input during a period of twenty-four hours

This efficiency is considered only on transformers giving intermittent or variable service.

In order to avoid complication in calculations, the variable or intermittent load is reduced to watt-hour equivalent.

Ordinary lighting transformers may be considered as delivering full load for four hours, no load for twenty hours. The all-day efficiency in example above may be calculated as follows:

Output	3000 × 4 =	12000 w. hrs.
Input	12000 w.hrs.	
Iron loss for 24 hrs...	1368 w.hrs.	13638 w. hrs.
Copper loss for 24 hrs.	270 w.hrs.	

Per cent efficiency = $\frac{12000 \times 100}{13638}$ = 87.9 per cent.

Telephone Growth in the United States as Compared with Other Countries.

In a pamphlet issued in connection with the St. Louis Exposition, the American Telephone and Telegraph Company gives some interesting statistics of telephone growth in the United States, and also makes comparisons of the telephone in this country and in Europe.

Following are some figures showing the growth of the Bell telephone in the United States:

	Subscribers January 1.	Subscribers to Population.	No. Talks per Inhabitant.	Total Talks Daily (est.)	No. Towns. Connected.
1881	47,880	1 to 1074	2	300,000	403
1885	134,847	1 to 418	4	753,180	1,600
1890	185,003	1 to 340	8	1,447,995	2,820
1895	243,432	1 to 283	12	2,402,543	5,610
1900	632,946	1 to 120	25	5,817,514	11,572
1904	1,525,167	1 to 53	42	10,134,020	26,128

The following table shows the number of telephone subscribers in the leading countries in Europe on January 1, 1902, as compared with the number of Bell subscribers on that date in the United States:

Country:	No. Subscribers Jan. 1, 1902.
German Empire	341,134
Great Britain	231,998
Sweden	87,518
France	81,905
Switzerland	44,203
Russia	39,557
Norway	35,398
Austria	35,218
Denmark	35,178
Spain	18,083
Italy	17,986
Other countries	76,248
Total Europe	1,044,303
Total United States	1,020,647
Total Canada	43,658
Total United States, 1904	1,525,167

The ratio of subscribers to population in Europe ranges from 1 to 16,219 in Bosnia to 1 to 58 in Sweden. The ratio for all Europe was 1 to 368, compared with 1 to 76 for the United States in that year, and 1 to 53 in 1904.

Other statistics of the United States, Canada and Europe are shown as follows (January 1, 1902):

	Miles of Wire.	Average Daily Talks.
United States	2,445,284	7,719,000
Europe	2,362,962	6,785,000
Canada	94,314	480,000

The following table shows the relative importance of the telegraph, the telephone, and the mail, as serving the people of the United States:

Communications, 1903:

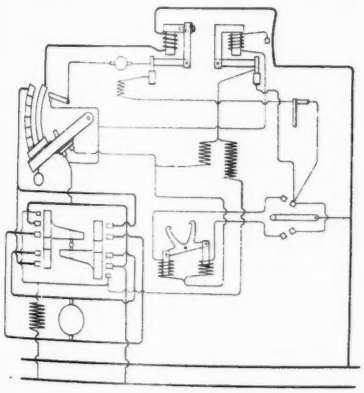
Telegraph	92,000,000
Telephone	3,263,000,000
U. S. mail	5,084,000,000

Wireless Telegraphy on the Marsden.

The British government will establish a space-telegraph station on the Marsden some three miles from South Shields. The station is to be used chiefly for communication with warships.

Electrical Patents.

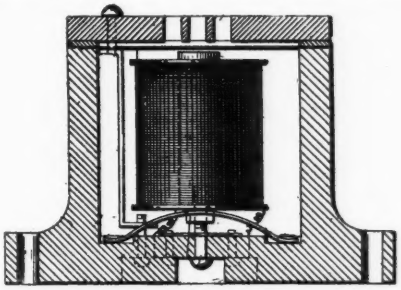
Gustaf Rennerfelt, of New York, N. Y., has been awarded patent No. 769,406, dated September 6, 1904, a means for controlling and regulating electric motors. This invention has for its objects, first, to provide means for preventing the abnormal flow of current through an electric motor upon starting the same; second, to provide means for preventing abnormal speeding of an electric motor upon starting the same; third, to provide means for automatically rupturing the current flow through an electric motor in the event of an overheating of the same; fourth, to devise apparatus in which all the aforesaid three objects will result automatically and in which the manual operation shall be limited to the closing of a single electrical contact; and fifth, to so arrange said apparatus that a minimum amount of energy will be wasted in its operation and also so that it shall be simple and cheap in construction. In the use of electric motors, as heretofore regulated and controlled, an attendant may often carelessly switch the current through the motor in such quantity as to seriously damage the



Means for Controlling and Regulating Motors.

same, and particularly is this true when the motor is carrying or moving a relatively heavy load. It also often occurs that the motor may be started with greater acceleration than desirable, and particularly is this true when the motor is moving a relatively light load. The invention is designed to overcome these objections, and to this end a pilot-motor is used for intermittently moving the regulator, its movement being stopped when the starting current exceeds a predetermined limit, and also when the acceleration rate exceeds a predetermined limit and means are provided whereby both of said limits can be easily adjusted, so that the same apparatus may be used for different motor installations with varying requirements. It consists of an electric motor provided with an automatic regulator adapted to successively increase the speed of the motor, in combination with an acceleration controller connected to and driven by the motor and adapted to stop the regulator when the acceleration rate exceeds a predetermined limit.

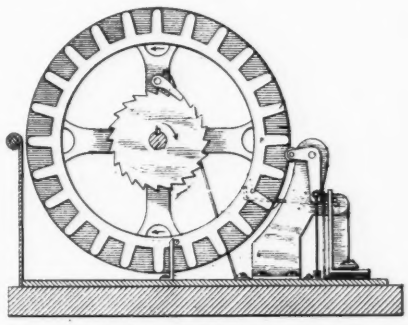
Joseph P. Gillette, New London, Ct., has been awarded patent No. 769,540, dated September 6, 1904, on an audible



Audible Indicator for Light or Motor Circuit.

indicator for electric light or electric motor circuits. The invention relates to an improvement in audible indicators for electric light or electric motor currents, the object being to produce a simple, compact, convenient and effective device for calling attention to currents used only a portion of the time, such as incandescent lamps located in cellars or other retired places, and motors, and to remind the user to shut them off. The device is adapted to be connected in series in such circuits. It consists of an audible indicator, the combination with a shell having lateral openings, of a cover for the shell, a magnet located in the shell, a vibrator coacting with the magnet to produce an audible signal, a magnet-supporting spring located in the bottom of the shell, means located in the bottom of the shell for adjusting the magnet with respect to the vibrator against the tension of the said spring, and connections to and from the magnet through the said lateral opening in the shell.

John K. Norstrom and Henry M. Graif, of Chicago, Ill., have been awarded patent No. 769,228, dated September 6, 1904, for an electric circuit-closer. The patent has been assigned to the Automatic Telephone Company, of Chicago, Ill., a corporation of Illinois. This invention relates to improvements in electric circuit-closers adapted to close one or more electric circuits a determinate number of times by the continuous movement of an actuating member. The primary object of the invention is to provide a circuit-closer of the type described wherein the primary actuating member is adapted to be rotated manually in one direction without effecting the closing of the circuit controlled by the circuit-closer, and wherein said primary member is adapted when released to return automatically to its initial position, in its return movement automatically closing the circuit a determinate number of times, dependent upon the extent of its initial manual movement. A further object of the invention is to provide an arrangement of a plurality of rotatable primary actuating devices of the character described, each arranged to close a circuit, and instrumentalities auxiliary to the primary actuating devices, all so arranged that each primary actuating device when initially rotated is held in such position until all of the primary devices have been so set and that upon the release of one of said primary actuating devices the others are successively automatically released to permit them to perform their circuit-closing functions. Another object of the invention is to provide an arrangement whereby the speed of return of the primary actuating devices is equalized. A further object is to simplify and generally improve the construction of devices of the general character specified. It consists of two rotatable, toothed wheels, circuit-closing springs associated with



Electric Circuit-Closer.

each wheel, a movable transmitting instrumentality interposed between each wheel and its contact-springs normally arranged to intercept the path of movement of the wheel-teeth and to be moved therefrom by the teeth in operation, a holding device associated with each transmitting instrumentality adapted to prevent movement thereof from the path of the teeth of the wheel, and means carried by one wheel arranged and adapted to move the holding device of the transmitting instrumentality associated with the other wheel into operative position.

The X-Ray in Leukemia.

Dr. Bozzali, director of clinical medicine at Turin University, has informed the Academy of Medicine that he has cured, by means of the X-ray, a supposedly incurable case of leukemia.

Reviews of Current Engineering and Scientific Literature.

The Hydroelectric Station of Plan Du Var, France.

La Société Energie Electrique, of the Mediterranean coast, has installed a number of electrical distributing systems in southern France. One of the most recent has been installed at Plan du Var. The plant is not exceptional in any way, and has an output of only about 600 kilowatts. It is, however, typical of this important system. The generator is a 600-kilowatt, three-phase alternator, directly connected to a horizontal Francis turbine. It operates at a frequency of twenty-five cycles per second, and gives directly 11,000 volts. The speed is 375 revolutions per minute. It is of the revolving-field type, and the exciting current is furnished at sixty volts. This machine is constructed to withstand mechanical strains when revolved at double speed. The armature was tested at 25,000 volts cool, and at 18,000 volts when hot, these pressures being applied for one minute. The head of water available varies from twenty-five to twenty-seven metres. The turbine is placed six and three-quarter metres above the tail-race. In addition to the main generators and the exciter, there is a small compound dynamo which supplies the lights and charges a storage battery. The latter is used to operate the high-tension oil-break switches. A second unit will ultimately be installed in this station. The power is distributed to various industries throughout the valley of the Var.—*Translated and abstracted from L'Électricien (Paris), August* 27.

The Dangers of Grease in Boiler Feed Water.

One of the most troublesome causes of overheating in steam boilers is that produced by the combination of greases with the fine, flour-like deposit which is precipitated when the feed water is impregnated with carbonate of lime or magnesia. Trouble arises partly from the insidious nature of the overheating, and partly from the difficulty of impressing on steam users the importance, in view of this particular deposit, of rigorously excluding the feed water from contamination with grease. A recent boiler inspection report referred to some interesting cases which have a rather instructive bearing on the matter. One case was that of a Lancashire boiler which apparently was built in conformity to exacting requirements. The working pressure was seventy-five pounds per square inch, and the boiler was fed with water from a surface condenser, the waste being made up with water containing a large quantity of carbonate of lime. There was no filter to remove the grease from the condensed steam, and it consequently passed into the boiler with the feed. The result was constant trouble with the furnaces bulging and leakage at the seams, grooving at the edges of the Bowling hoops, and of the front end-plate, ending finally with the fracture of the front end-plate and several of the hoops. When the damage had become so great as to necessitate the stoppage of the boiler for repairs, a new front end-plate and furnace were put in, and a grease separator interposed between the low-pressure cylinder of the engine and the condenser. No further trouble has been experienced.—*Abstracted from the Mechanical Engineer (London), September* 3.

The Action of Lightning Strokes on Buildings.

In a paper entitled "The Protection of Buildings from Lightning," Mr. Killingworth Hedges takes up a number of questions connected with this topic. The principal causes of the failure of the usual style of lightning-rod, as fitted on the buildings investigated, appeared to be due to the following: first, insufficient number of conductor and earth connections; second, the absence of any system of connecting the metallic portions of the buildings to the lightning conductor, especially the interconnection of the finials, rain-water pipes and girders. In the author's opinion, frequent damage by side flash from the conductors might be lessened by running a horizontal conductor along the ridge or along the parapets of all the roofs, somewhat after the method which is almost universally adopted in central Europe. With few exceptions, the protection investigated had a common defect, in that nearly all the earth-plates were merely buried in the ground close to the foundations of the building. Owing to drainage, this ground soon became dry, and consequently of high resistance. Architects, as a rule, object to sufficiently deep holes being made near a structure, consequently, the permanently moist ground is not reached. The author suggests a tubular earth which can be kept moist by leading a small tube from the nearest rain-water pipe. The general conclusions arrived at by the author are, that there is very little advantage in placing isolated rods on an ordinary building, unless it has a high tower. A church, for instance, with a spire should have at least two conductors from top to earth. Even then if any other part of the structure happens to be in the path of a discharge from a cloud to the ground, the stroke may disregard the protected towers or spire and fall on the building, choosing some lower point.—*Abstracted from the Electrical Engineer (London), September* 2.

Power, Economical and Otherwise.

A comparison is made here of the operation of an old reciprocating steam engine, with a normal rating of thirty-five horse-power—and which actually developed anything up to sixty horse-power—and a gas engine which replaced it. About forty-five horse-power was required to drive the mill. For this purpose the engine, which was an old one, though of a good type, consumed twenty-five hundredweight of good Scotch coal. When it became necessary to replace the old plant, four methods were possible: a new steam engine and boiler, a source of water power three miles distant, an oil engine, or a gas engine. The choice fell upon the gas engine, to be supplied with gas from a producer. The plant, as installed, is comparatively simple, consisting of a generator burning anthracite coal or coke, a water-jacket for cooling the gases, two scrubbers, and an expansion box near the engine. A fifty-horse-power gas engine was selected, and belt driving was adopted to overcome the objection to the irregularity of the engine. Comparing the old system with the new, it is seen that the engine required a room twenty-nine by eleven feet, and the boiler a space of twenty-five feet by nine feet, a total of 558 square feet. The gas engine requires a space of only eighteen feet by thirteen feet, and the producer a space of fifteen by ten feet, a total of only 384 square feet. The fuel consumption of the gas engine never exceeds five hundredweight per day. The power for this system costs 0.32 cent per horse-power-hour, while with the old engine it cost 1.13 cents per hour. There are, however, some objections to the gas engine. Unless it is watched carefully, it gives trouble, but if kept clean and the scrubbers are cleaned out regularly, very

little attention is necessary. With this plant it was found necessary to clean the exhaust valve in the engine twice a week, and to clean both gas and air valves once in two weeks. The electric ignition system must be cleaned twice a week. If this work is done regularly, it does not take much time, and the plant operates very free from trouble. It is estimated that the depreciation would be about ten per cent, as the upkeep of the gas engine is slightly higher than that of a steam engine. This is offset somewhat by the lower depreciation of a producer plant, as compared with a steam boiler. As a source of power, producer gas is highly to be recommended where an occasional stoppage in a day's work is not of vital importance, but in all other cases, it has hardly attained a sufficient pitch of reliability to warrant its introduction.—*Abstracted from the Electrical Engineer (London), August 26.*

New Apparatus for the Production of High-Frequency Currents.

When high-frequency currents are desired to operate electrotherapeutic or wireless telegraph apparatus, it has been found undesirable to draw the required power from the public system. The difficulties of doing this are several: the high voltage set up by the interrupter throws a considerable strain on the insulation of the commercial apparatus connected to the system, endangering its operation, and it is difficult to construct transformers giving the required high voltage. To overcome these difficulties, Messrs. d'Arsonval and Gaiffe have devised a system which is here described by M. A. Soulier. The first step was to modify the method of constructing the apparatus so as to allow a considerable increase in insulation. The causes bringing about deterioration were studied, and a method found for avoiding them. It was found that the Hertzian waves which are set up in the high-frequency circuit are set up also in all circuits connected to it either inductively or conductively. The voltage thus thrown on the system has a maximum equal to that which produces the spark in the interrupter, and this sets up between the neighboring wires of any windings differences of potential much greater than they have been designed to withstand. To damp out these oscillations, Messrs. d'Arsonval and Gaiffe connect a system of condensers and resistances between the transformer and the condenser in the high-frequency circuit. The resistances in this circuit damp out, by the heating effect, the high-frequency currents, and the condensers can discharge but slowly. Thus, the difference of potentials set up at the terminals of the transformer is much reduced, the amount of reduction depending upon the size of the resistance and the capacity of the condensers. The transformer then operates as an industrial transformer, the high-frequency oscillations not penetrating it. In searching for means to prevent arcing at the interrupter, it was observed that this arc is produced the more easily the greater the self-induction of the high-frequency circuit. By making a circuit with all conductors as short as possible, the inductance being reduced to a minimum, all difficulty from arcing disappeared. The diagram of connections for the circuits finally adopted shows a shunt circuit containing four condensers connected across the terminals of the transformer. In parallel with this shunt circuit is the circuit containing the interrupter and the two high resistances. The high-frequency circuit is formed of four condensers connected directly across the interrupter, the apparatus making use of this current being connected in series in this circuit.—*Translated and abstracted from L'Industrie Electrique (Paris), August 25.*

Rail Stresses.

Within certain limits few engineering materials are called upon to withstand such heavy straining actions as are the rails of a railway line carrying a fast and heavy traffic. Although the load on a rail is of such character that the "impact factor" must necessarily be very large, the metal used generally contains about four to five times as much carbon as is admitted into a boiler plate. In spite of this, or perhaps because of it, rail fractures are relatively rare. The permanent sets which rails are compelled to take are much less than those to which a boiler or a ship-plate is subjected while being worked up into a boiler shell or the side plating of a ship. The fact that rails carry their loads so successfully is of high interest, considering the extremely heavy stresses to which they are subjected. These stresses are known to be high, but it is by no means easy to estimate accurately their intensity. When laid on the trough floor of a bridge, the ordinary theory of elasticity enables a close approximation to be made of the rail stresses, which, even with the load at rest, may amount to seven or eight tons per square inch, an intensity which is doubtless largely augmented by impact when the load moves over the track at an express speed. With rails laid on the solid ground, however, the requisite data are wanting to permit of any reliable analysis of the stresses obtaining. The problem is complicated by the fact that the "solid" ground is far from rigid. As the train covers a length of track, the whole sinks bodily, the relative deflection of two neighboring points of the rail being small compared with the total compression of the roadbed, so that any attempt to calculate the stresses as equivalent to those obtaining in a continuous girder supported on rigid piers leads to quite unreliable results. Mr. A. Flamache, chief engineer to the Belgian state railways, considers this matter at some length. He holds that the true stresses in the rail must be less than if the load were equally distributed over every sleeper under the engine, and must be greater than if the sleeper reactions varied as the ordinates of a triangle, the base being equal to the length of the engine, and the apex at its centre of gravity. This he calls a triangular disposition of the reactions. He calculates out the rail stresses on both these hypotheses, and, comparing the results with actual observations on rails, arrives at the conclusion that the first supposition is that nearest the actual facts of the case. The maximum bending moment is thus not greatly different from $\frac{PL}{6}$, where P is the load on one wheel, and L is the distance between consecutive axles. In other words, the actual rail stresses occasioned by a modern locomotive at rest on an eighty-pound rail may readily reach some ten tons per square inch. The maximum stress with the track supported on a yielding base of the character stated is always directly under the load, and this maximum is little different, whether the wheel rests directly over a sleeper, or centrally between two. Accumulating experience seems to show that the strength of material is not a function of the range of the stress to which it is subjected only, but also of the frequency with which the load is renewed. In view of Roberts-Austen's experiments on diffusion in solids, and of the Ewing-Rosenhain discovery of slipping surfaces in overstrained metal, this hypothesis appears a rational one. If the slipping surfaces are given time to recover, they may weld up again by a process of diffusion, and the overstrained metal be as good as ever; but if the slip is kept continuously in movement, a crack will develop, resulting at last in the breakage of the overstrained part.—*Abstracted from Engineering (London), September 2.*

INDUSTRIAL SECTION.

ILLUSTRATED DESCRIPTIONS OF NEW AND STANDARD ELECTRICAL AND MECHANICAL APPARATUS.

Telephone Development in New York City.

Some interesting facts respecting the growth of the New York Telephone Company during the past ten years were recently secured by a representative of this journal.

In 1894, the old method of charging a fixed yearly rental for telephones regardless of their use was done away with, and in readjusting the rate schedule the message was adopted as the unit of measure. At this time, the reconstruction from overhead to underground lines had been practically completed and the plant was in excellent condition. The improvement in the service, together with the new rate system, which brought telephone service within the means of the moderate user, resulted in a general demand for telephones.

In 1894, the number of telephones in service in Manhattan and the Bronx was 11,835. In 1899, five years later, the total number was 39,508, an increase of 27,673, over 200 per cent. By this time the utility of the telephone had become generally recognized, and the so-called "telephone-habit" was growing with rapidity. In 1900, the change from the magneto to the common battery system of operation was fairly under way, and by 1902 all of the Manhattan exchanges were operating on this method.

From 1899 up to the present time the growth of business has been ever increasing. The number of telephones in service in Manhattan and the Bronx had increased by 1900 to 53,205; 1901, 72,187; 1902, 96,364; an actual gain this latter year of over 24,000. In 1903, a still better showing was made, 121,935 stations being in service at the end of December in that year. That the rapid telephone development has not by any means reached its limit in this city is evidenced by the fact that on September 1, 1904, the number of telephones connected and under contract in Manhattan and the Bronx was 144,495.

Two interesting features of this development are the growth of private branch exchanges and the general extension of residence telephone service. In the private branch exchange service a switchboard is located on the subscriber's premises, connected to an exchange by two or more trunk lines. To this switchboard are connected as many telephones, either on or off the premises, as are desired. By this means a splendid interior system is furnished, and at the same time each telephone is capable of immediate connection with any other telephone reached by local or long-distance wires.

The service is largely used, and is especially useful, in hotels and apartment houses. There are about 5,000 of these private branch exchanges in New York city, aggregating 60,000 telephones, and ranging in size from the Waldorf-Astoria system, embracing 1,100 telephones, to the smallest office system of two telephones.

There has been a general residence telephone development, outside of the apartment houses and hotels. The telephone is a very useful adjunct to a household, and the reasonable rates have brought the service within the means of nearly every one desiring it.

The success of the New York Telephone Company has been due to the adequate, prompt and courteous service which it renders at a reasonable rate.

The Brown Hoisting Machinery Company's Exhibit at the St. Louis Exposition.

The Brown Hoisting Machinery Company has an interesting exhibit in Machinery Hall, at the World's Fair, St. Louis, showing two locomotive cranes, one of fifteen tons, and one of ten tons lifting capacity. Both of these cranes were used by the Exposition company in installing heavy exhibits and will be used again when the exposition is over for dismantling and reloading exhibits.

The ten-ton locomotive crane has a thirty-foot boom, and is equipped with a Brownhoist two-rope ore grab bucket and is shown in operation shoveling iron ore from a twelve-foot circular pit under the crane. The operation of this crane seems very interesting, judging from the large crowds which gather to see it each day.

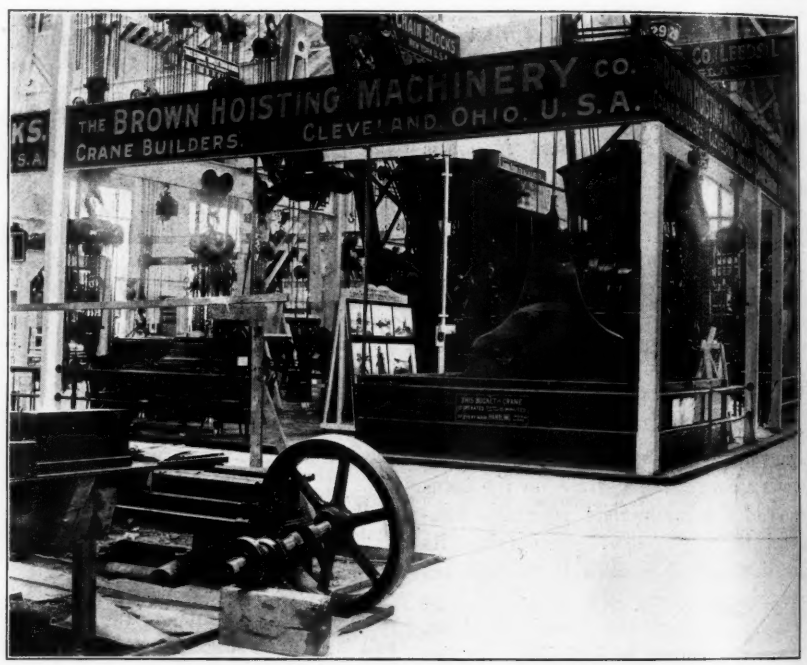


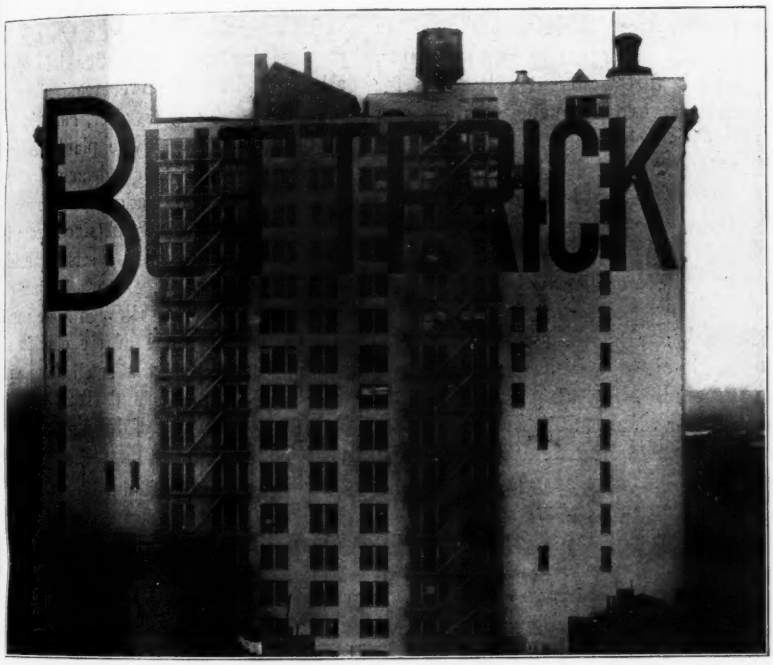
EXHIBIT AT THE WORLD'S FAIR, ST. LOUIS, OF THE BROWN HOISTING MACHINERY COMPANY.

In addition to these two locomotive cranes, the Brown Hoisting Machinery Company exhibits at St. Louis a full line of its overhead trolleys and tramrail, including plain and geared trolleys and electrically operated trolleys, the latter in operation.

This company is also distributing to every one visiting the exhibit, a pack of "Crane Cards," consisting of sixteen colored cards in each pack, each card descriptive of a standard type of crane built by it. These cards were produced especially for the St. Louis exposition, and are free to all who will call in person at the exhibit for them.

A Large Electrically Illuminated Sign.

From the New Jersey shore, or from the ferryboats that cross or ply up and down the Hudson river, may be seen the large building of the Butterick Publishing Company. It is located on Spring and McDougall streets, New York city, and is about 225 feet high. Because of the unobstructed view that it has from the west, the management of the Butterick Publishing Company conceived the idea that if a large painted sign was made high up on the west wall, it would be good advertising. On account of the many windows, which were really obstructions on this west wall, the matter of painting a good legible sign was not as easy as was first expected, and the services of architects of the building were enlisted, with the result that after some conniving and engineering skill, the sign was laid out and the blue-prints were turned over to the painter to successfully carry them out.



A Very Large Electrically Illuminated Sign.

This is the brief history of what is, perhaps, the largest painted sign in the world.

Numerous guesses by those who have stood on the decks of ferryboats have been made as to the height of the letters, and it has been a fact worthy of note that invariably the guesses were all far short. The upright member of the initial letter "B" extends over a distance of sixty-eight feet and the other letters are fifty feet high. The individual members of the letters are five feet in width. From these dimensions it may be imagined, if one has not seen the sign, how huge and how prominent it must be.

The management of this large publishing house were pleased with the painted sign when it was finished, but it did not take them long, however, to realize that they had only a day sign, that their valuable wall from an advertising standpoint was of no value to them at night. They hesitated before thinking it possible that this sign could be artificially illuminated, but they determined to seek expert advice on this subject. They appealed to Mr. Arthur Williams, the efficient general inspector of the New York Edison Company, whose long experience in solving such problems is well known among electrical engineers generally. He assured the owners of the building that such a task could be successfully accomplished and advised them to take up the whole matter with the engineers of the Electric Motor and Equipment Company, Newark, N. J., who, as practical electric sign makers, could consider the details and work out some reasonable plan.

The first thought was of the possibility of illuminating the letters by a system of reflected light. After careful thought and due consideration this scheme was abandoned and it was concluded that the letters could best be seen outlined with incandescent lamps, but of what candle-power and what distance apart these should be, were unknown quantities yet to be determined.

It was decided to conduct a series of experiments, the first one being to ascertain how lines of incandescent lamps of different candle-powers and with different spacings, in regard to each other, would appear on the wall. Thus, several strips were lowered down from the roof and a view of these was taken from a ferryboat on the Hudson river.

After some deliberation it was decided to use four-candle-power lamps, spaced eighteen inches apart, on the members of the letters. It was observed that the vertical members of some of the letters which were close together seemed to blur, and to guard against this in subsequent experiments that were made, shields were provided to keep the light, from the individual lamps, away from the background which acted as a reflector and directly caused the blurring appearance.

(It should be noted that the letters themselves are a flat black, and the wall is a bright buff.) Now, by this method the box-construction reflecting surface was not depended upon at all, and the individual lamps are depended upon to outline the letters as they now appear in the painted sign. Although perfectly sanguine of success, should the management of the company place the order, the Electric Motor and Equipment Company subsequently outlined two of the letters of the sign for the benefit of, and at the suggestion of, the management of the publishing company.

So marked was the success of this, and so much pleased were those who saw it, that the engineers were invited to present a specification and a proposition covering the wiring for the installation of the entire sign.

After deliberation of only a few days the order was placed and the work was begun on the manufacturing and installation of the largest electrically illuminated sign in the world.

Hydroelectric Statistics.

The total amount of hydroelectric power in the world is nearly 2,000,000 horse-power. In its distribution the United States leads with 527,467; Canada is second with 228,225; Italy third with 210,000. Other countries take the following order: France, 161,343; Switzerland, 133,302; Germany, 81,077; Sweden, 71,000; Mexico, 18,470; Austria, 16,000; Great Britain, 11,906; Russia, 10,000; India, 7,050; Japan, 3,450; South Africa, 2,100; Venezuela, 1,200; Brazil, 800; in all a total of 1,483,300 horse-power.

The Operating Switchboard—Louisiana Purchase Exposition.

Across the central portion of the western wall of the Palace of Machinery, overlooking the generators which supply lights and motors throughout the exposition, extend two large galleries in which are located the apparatus by means of which the dynamos are regulated and controlled and their current distributed to every building in the grounds. The service plant, of which this apparatus is a part, is a thoroughly modern central station with a rated capacity of 8,000 kilowatts divided into four units of 2,000 kilowatts each. Three-phase current is generated at 6,600 volts potential, 3,000 alternations per minute.

In a large central station the operating switchboard is the key of the entire plant, and on its design and construction, in a large degree, depends the success of the installation. In no department of station equipment has greater progress been made during recent years. Higher operating potentials and increasing capacities have necessitated the use of switching devices too heavy for manual working and have led to the separation of controlling board and operating apparatus. Distant control of oil break switches, and instruments connected through reducing transformers, has freed the controlling board both front and rear from high potentials, and removed all danger to the operating engineer.

The operating switchboard for the exposition service plant was designed and constructed by the Westinghouse Electric and Manufacturing Company, of Pittsburg, Pa., to whom was awarded the contract for the entire steam and electric equipment, and was erected under the supervision of Westinghouse, Church, Kerr & Company, the consulting engineers.

The control, or operating section of the board, located in the upper gallery, consists of twenty-nine panels of selected blue Vermont marble, two inches thick, highly polished, and supported by an angle iron frame. Each panel is ninety inches high, divided into two parts, the lower marble slab in every case carrying the integrating wattmeter for the generator or feeder to which the panel is assigned. For the three-phase circuit from each generator and to each feeder, there is a separate panel from which is operated the apparatus necessary for its individual control. The generator panels are thirty-two inches in width, the feeder and exciter panels twenty-four inches. The total length of the controlling switchboard is sixty-two feet.

At the extreme left, as we face the board, the first three panels control the three 125-volt, direct-current, engine-driven exciter sets. The arrangement includes a single set of busses, to which all the exciters may be connected in multiple and from which current is led to the generator fields. Each panel is equipped with direct-current ammeter, main switches, exciter field rheostat and mechanism for the distant control of the electrically operated single pole equalizer switch, which is mounted on a pedestal near its exciter set.

At the extreme left, attached to panel No. 1, is a set of swinging arms on which are mounted three type F alternating-current voltmeters, arranged so they may be connected to any generator, two type D direct-current voltmeters for the exciters, two frequency meters and one type B synchroscope.

Panels 4, 5, 6 and 7 are equipped for the control of the large alternators in the service plant. Panels 4 and 5 were constructed by the General Electric Company and are duplicates in every respect, each containing three alternating-current ammeters, one direct-current ammeter, two single-phase indicating wattmeters, one polyphase integrating wattmeter, one power-factor meter and operating devices for the motor-driven field rheostats and motor-operated main switches.

The instruments on panels 4 and 5 and on panel 29 and the apparatus in the circuits which they control, were furnished by the General Electric Company. With the exceptions noted, all apparatus and instruments are of Westinghouse standard design and construction.

Panels 6 and 7 are each equipped with three alternating-current ammeters, one direct-current ammeter, one polyphase indicating wattmeter, one power-factor meter, controllers, indicators, etc., for the motor-driven field rheostats and electrically operated oil switches in the generator circuits.

As has been indicated, the generator field rheostats are all motor operated and controlled from the generator switchboard panels. From these panels, by means of motor-operated adjustments on the engine governors, the speed of the generators is also controlled and may be varied at the will of the operator and the synchronizing of an incoming machine easily and accurately performed.

The switchboard is provided with two sets of three-phase high-potential bus-bars. Panels 9 and 10 are arranged to measure and record the output of the entire station, each being connected to one set of busses and equipped with three ammeters, one polyphase indicating watt-meter, one polyphase integrating watt-meter and two static ground detectors.

Of the twenty remaining panels, seventeen are designed for the control of the primary high-potential feeder circuits leading from the generating plant to the transformer stations throughout the exposition. Each panel is equipped with three type F ammeters, one type A polyphase wattmeter and mechanism for the control of the electrically operated switches in the feeder circuit.

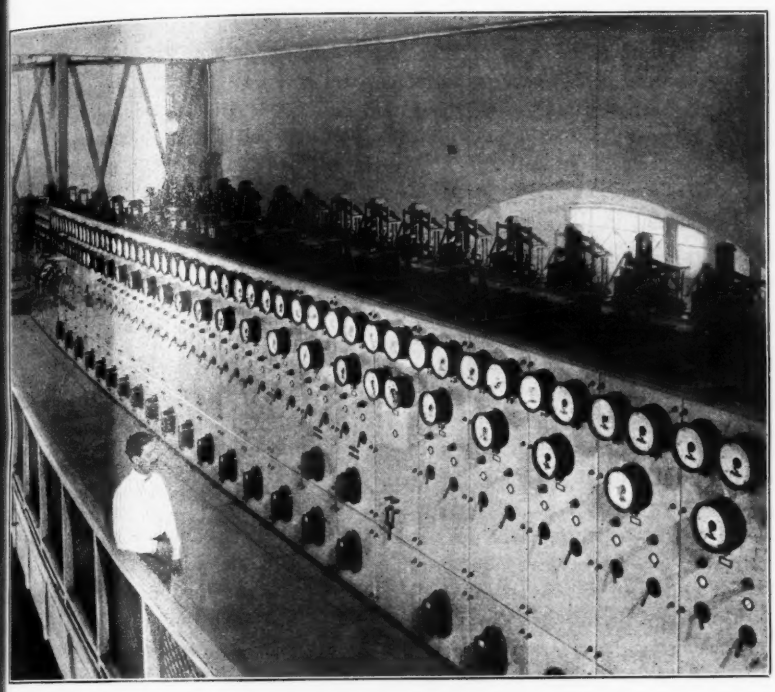
Panels 21 and 22 were originally arranged to connect either set of bus-bars to the lines of the Union Electric Light and Power Company of St. Louis, as the service plant was not designed to supply all the light and power required by the exposition. This, however, has not been necessary as the service plant has been equal to all ordinary demands of the exposition and the additional power required has been easily obtained from two of the larger generating sets on exhibit in the Palace of Machinery, proper connections being made through these panels. The power required of the exhibit machines has been but a small fraction of their rated capacity and that but for an hour or two each day, during the extreme peak of the load.

Panel 22 was constructed for the purpose of introducing resistance into the "decorative circuits" or feeders which supply current to the lamps illuminating the exterior of the buildings, in order that they might be gradually brought up to full power or dimmed at the will of the operator. As yet, the resistance arrangement has not been put in service as it has been found feasible to control the illuminating effect by direct variation of the generator voltage, one machine being set apart for the "decorative circuits."

The high-potential busses are supported on a solid structure of brickwork, separated by barriers of soap-stone and protected in every way suggested by modern practice of the highest class. The construction renders short-circuit or insulation failure practically impossible. Leads of triple conductor, lead covered cable come up from the generators and distributing circuits protected by barriers of lithosite and soap-stone.

The instrument transformers are mounted on the gallery floor, below the bus-bars, each in its own compartment between soap-stone barriers. Other switchboard apparatus is protected in similar ways. The whole construction is exceedingly substantial and thoroughly fire-

proof. The instrument circuits are protected by long enclosed fuses, and disconnecting switches of the hook type are inserted in every main circuit, though, naturally, they are never intended to open a circuit under load.



THE OPERATING SWITCHBOARD AT THE SERVICE PLANT OF THE LOUISIANA PURCHASE EXPOSITION.

The electrically operated oil circuit-breakers for the generator and feed circuits are mounted for the most part in the upper gallery, behind and to the sides of the controlling panels. A few are mounted in the lower gallery.

For each generator there are two three-pole electrically operated oil break circuit-breakers of the non-automatic type, one for each set of bus-bars, with interlocking devices so arranged that it is impossible that both be closed at the same time. The switches furnished by the Westinghouse company are its standard type C, non-automatic, distant control, electrically operated circuit-breakers; those furnished by the General Electric Company of corresponding construction, but operated by small direct-current motors.

For each feeder circuit, two main three-pole switches are furnished, one for each set of busses, interlocked to prevent misconnection. All are Westinghouse type C oil circuit-breakers, with distant control and automatic release. These switches are operated by a solenoid-controlled toggle, are erected in brick structures with a separate oil tank for each pole, and a separate fireproof compartment for each oil tank. There are two stationary contacts per pole, one connecting to the incoming and one to the outgoing lead of the same phase, each contact mounted within a large porcelain insulator. There are two breaks in every leg. These breaks take place in the upper part of the enclosing chamber where the oil is clear and free and, moreover, the insulating operating rod which carries the contacts serves as a barrier, making it practically impossible for an arc to jump across. Current to operate all the switches is supplied by the exciter sets.

The instruments mounted on the face of the controlling panels are finished in black enamel, with edges and finished parts in black oxide.

The service switchboard is a model exhibit of the best engineering practice, complete in every detail, fireproof and indestructible. The high-potential leads and buses are well separated and skilfully protected. The arrangement of apparatus and circuits is both safe and convenient. The system of connection and control is flexible and easily handled. The operating board presents no live high-potential contacts to endanger the operator. The instruments are all connected to the lines through reducing transformers.

Engineers visiting the great exposition will do well to examine this feature of the operating plant.

Electric Elevator for Liberty Statue.

The war department has assumed control of Bedloe's Island and the Statue of Liberty, and will overhaul and repair the statue, which has been considerably affected by exposure. In addition to the renovation, an electric passenger elevator will be installed.

Some Pardridge Specialties.

The Pardridge Shade and Reflector Company, Chicago, Ill., announces a ready sale in Chicago and elsewhere of several

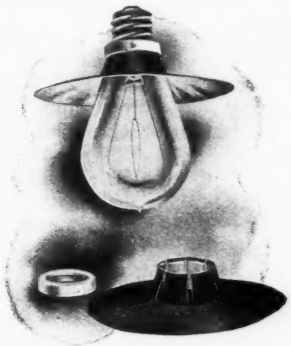


FIG. 1.—REFLECTOR.

of its electrical specialties. The accompanying illustrations present several of these. Fig. 1 is a small reflector that fits directly over the lamp. This reflector is so fashioned that it spreads the rays

FIG. 2.—LAMP-CHANGER.

from the lamp over a large area, and, at the same time, does not darken the background. It is made of brass, finished in nickel-plate and white enamel, the one for indoor work, and the other for outdoor

FIG. 3.—CORD ADJUSTER.

service. The company has sold over 80,000 of these reflectors since it began business nine months ago. The larger theatres and hotels in Chicago are using them, and a number of large manufactur-

ing plants in and around Chicago have also been supplied. It is stated that these reflectors will increase the light from 300 to 500 per cent. They are very durable, and can be fitted to any lamp without an extra fixture.

Fig. 2 shows the Pardridge lamp-changer. This is considered a most simple device for the easy removal of lamps. It takes any lamp from a four-candle-power to a thirty-two-candle-power. The demand for this article has been to the extent of almost 500 in Chicago alone. It does away with the necessity of using a ladder for interior work, and eliminates the building of scaffolds for removing lamps from high places on outside construction.

Fig. 3 shows the Pardridge "Easy" cord adjuster. This device is easily adjusted to any drop light after the socket has been attached. It is made of fibre insulation, and is strong and durable. Over 50,000 of these adjusters have been disposed of within the last three months.

Mr. A. J. Pardridge, president of the Pardridge Shade and Reflector Company, has applied for patents on these articles, both in the United States and all the foreign countries. From present indications it is expected that the fall business of this company will triple that of last season.

The Exhibit of C. H. Bradley & Company at St. Louis.

The engine shown by C. H. Bradley, Jr., & Company, Pittsburg, Pa., in block 52, aisle 11, Machinery Building, World's Fair, St. Louis, was originally developed by Willans & Robinson, Rugby, England. It is a triple-expansion engine, the steam ports and valves between the three tandem cylinders being located in the common piston rod. There are two sets of cylinders, the cranks on the common shaft being set at right angles. The engine on exhibition is used in the exposition arc lighting service, and has the distinction of being built in accordance with the metric system throughout.

The condensing apparatus consists of a 2,000 square foot Worthington condenser, a Blake vertical, twin-beam air pump, and an eight-inch Worthington volute circulating pump. The vertical twin air pump was originally developed by the George F. Blake Manufacturing Company for marine service. There are two air cylinders placed side by side in a vertical position, with the steam cylinders directly above, the two piston rods being connected by a walking beam. A crank on the shaft of the walking beam operates the slide valve of a small cylinder, the piston of which is in reality the driving engine of the main steam cylinder valves. This is not a dry vacuum pump, but is intended to handle both air and the water of condensation. Its operation is noiseless and regular, the auxiliary valve mechanism giving complete and accurate control of the motions of the main pistons.

The Condensers in the Power Plant, Machinery Hall, St. Louis, Mo.

The condensers of the main power plant at the World's Fair, St. Louis, Mo., two in number and of the elevated jet type, were furnished by Henry R. Worthington. They are located in block 38, Machinery Hall, in the space between the columns supporting the building and the overhead cranes in order to clear the latter. At the junction of the horizontal and vertical lines of exhaust piping is located a cast-iron entrainer, which forms a water pocket, draining the horizontal pipe and so directing the exhaust steam that it will pick up any water collected in the pipe and carry it along to the condenser in the form of a spray. At the top of each exhaust riser is an automatic relief valve, which, in case of loss of vacuum, provides a safety vent to the atmosphere through a line of vertical spiral riveted pipe extending through the roof. A characteristic of this type of condenser is the use of separate water and dry vacuum pumps. The former in the present case are three Worthington turbine pumps in the Steam, Fuel and Gas Building, driven by Westinghouse single-acting engines.

The condenser is elevated about thirty feet above the hot well, and the water descends by gravity against the atmospheric pressure. The vacuum pumps are used to exhaust the air from the condenser and the steam pipe system. Before the air passes to this pump, however, it is cooled by an air-cooler in the injection pipe, which decreases its volume and practically frees it from water. The dry vacuum pumps differ from other vacuum pumps in that, as the name indicates, no water is used in the air cylinders, the pistons being lubricated by oil the same as the steam cylinders and the clearance spaces being reduced to a minimum, as in air compressors. To still further increase the efficiency of this apparatus, a small auxiliary valve is used, which after the exhaust valves have closed, opens a passage from one to the other side of the piston, and permits the gases in the clearance space to expand into the suction side of the cylinder. Before the piston starts on the return stroke this valve closes and, there being no gas or air under pressure in the cylinder or ports, it draws at once from the condenser. This method greatly increases both the capacity and efficiency of the pump. The absence of water and the positive control of the suction valve permit a high rotative speed.

Two of the vacuum pumps in the plant are of the horizontal type. The positive inlet and discharge valves are adjustable by a hand-wheel, while the steam is controlled by a slide valve with an adjustable eccentric to vary the point of cutoff, according to the steam pressure. The suction air valve is positively driven by an eccentric on the shaft, which is so set as to open the ports fully at the proper time, leaving an unobstructed passage for the attenuated air vapor to enter the cylinder. The steam and air pistons are on a common piston rod.

In addition to the horizontal vacuum pumps, there is one vertical pump, with an enclosed crank case, the air and steam pistons being on independent rods. The other features of the vertical machine, however, do not differ materially from the horizontal machine just described. All three pumps draw from a common vacuum header, which in turn is connected to the cones of the two condensers. The vacuum pumps are supplied with steam for the engine auxiliary piping system, and the exhaust is turned into the main condensing system. The air discharge is led through spiral piping to the roof. The condensers and dry vacuum pumps are located in Machinery Hall a short distance from the Westinghouse engines.

A Magneto-Call Local-Battery Switchboard Installation.

Although the general idea for present-day telephone equipment is in favor of central-energy apparatus, particularly where an exchange reaches over 300 or 400 immediate capacity, the American Electric Telephone Company, Chicago, Ill., announces a recent equipment for the Independent Telephone Company, at Beloit, Kan., which serves as an indication that there are still those who favor the magneto system.

A recent shipment made by this company consisted of a 500-line Bell express board, built up in two sections of three positions each. This switchboard is provided with a complete arrangement for rendering toll service, and the trunking circuits are so arranged as to operate in conjunction with a specially equipped toll line switchboard. The magneto board is arranged for an ultimate capacity of 1,200 lines, and each position of the switchboard may be equipped with 300 lines. The local trunk service between the operators is accomplished by the lamp transfer system.

CURRENT ELECTRICAL NEWS

DOMESTIC AND EXPORT.

WATER-POWER PLANT ON ELK CREEK, IDA.—Announcement has been made of a plan to take advantage of the natural water power of Elk creek falls, for supplying several large cities in Idaho with electricity. The Elk creek falls are fifty-two miles east of Moscow, Ida., and it is expected that most of the power will be used at this point.

MEXICAN LIGHTING COMPANY—The Compania Campechana de Electricidad y Fuera, capitalized at $150,000, has been organized for the purpose of building an electric light and power plant in the city of Campeche, Mexico. The company has a contract with the city to supply sixty arc and 300 incandescent lamps, for which a rental of $18,500 will be paid. It is also expected to supply at least 1,500 incandescent lamps to private parties, besides a number of other installations.

WATER-POWER PLANS FOR LEGHORN, ITALY—Messrs. Carlo Niemack & Company, Leghorn, Italy, are interested in the development of an extensive water power near that city. Surveys and estimates have been made showing about 8,000 horse-power and all of which could readily be utilized within practical transmission distances from the falls. Mr. Wilhelm Niemack, of the firm, is now touring the United States. He may be addressed in care of the Perkins company, Produce Exchange, New York.

PLAN TO PURCHASE STAMFORD TROLLEY COMPANY—It is reported that a deal is under way for the purchase of the New York & Stamford Trolley Company, which operates a road from Stamford, Ct., to Larchmont, N. Y. This system is capitalized at $1,600,000. The road has branches to all the shore resorts in Westchester County, N. Y. It is proposed to connect the trolley road with the New York Rapid Transit subway by extending it from Larchmont to Bronx Park, thereby completing a rapid transit system from New York east, touching Rye Beach, Glen Island and other shore resorts in New York.

PARKERSBURG, W. VA.—At a meeting of the directors of the Parkersburg & Ohio Valley Electric Railway Company, a contract was entered into between the Electric Railway Company and the Railway Construction Company, a local corporation, for the construction of an electric railroad between Sistersville and St. Marys. At the same time a meeting of the board of directors of the Railway Construction Company was held and the contract awarded by that company to the F. H. Blodgett Company for the construction of the first five miles of road from Sistersville to Friendly. The work will be commenced shortly and the first five miles completed by January 1.

SURVEYS COMPLETED FOR NEW MEXICO TROLLEY LINE—The surveys of the new route of the proposed electric railway from Guadalajara to Chapala, Mexico, have been completed, and it is expected that construction work will begin at once. The enterprise is backed by a syndicate of New York men. From Guadalajara to Chapala by the new route the distance is about thirty-six miles. Most of way, it is stated, the line will follow an old-established wagon road. With the exception of a few miles, the grade is light, and it is not believed that the cost of construction will be excessive. It is understood that the determining of a suitable route has been the cause of the delay in the construction of the road.

DANBURY, CT.—The Danbury & Harlem Traction Company has filed a certificate in the Westchester County register's office at White Plains, N. Y., showing that it has given a mortgage to the Knickerbocker Trust Company of New York. The mortgage is for $500,000, and it is given to secure a bond issue. The company will construct a street railway from Danbury to various points in the state of New York. A line between this city and Goldens Bridge, N. Y., was partially built several years ago, but operations, suspended on account of some technical complications, have not yet been resumed. Arrangements, however, for an early resumption of the work and for the extension of the system have been perfected. The new bonds, which have been issued in order to finance the enterprise, will mature in 1933.

ELECTRIFICATION OF WESTERN STEAM ROAD—The Colorado & Southern Railroad has been planning to electrify a part of its system for some time. It is now asserted that a part of the road will be fitted with accommodations for electric cars. A company has been incorporated with a capital of $3,000,000 to carry out the plan. The incorporation papers will cover the right to secure franchises for terminals in Denver, Col., and to operate electric lines on the streets of Denver, in competition with the Denver Tramway Company. The city will be offered a percentage of the gross earnings of the company. The company plans to build to Boulder, Idaho Springs, Louisville, Lafayette and Longmont. The organization will be known as the Denver & Interurban Railway Company.

INTERSTATE ELECTRIC RAILWAY—The Illinois Traction Company, which is interested with the McKinley syndicate in constructing an electric railroad line from Springfield, Ill., to St. Louis, Mo., has decided to build a line from Springfield to Quincy next spring. This enterprise will employ several million dollars. Application for the license to incorporate has been made, and it is expected that the company will be able to secure ample means to carry on the work. The road is to be called the Springfield, Beardstown & Quincy line. This is one of a series of branches which the McKinley syndicate has been building throughout the state of Illinois. The company has already lines out of Galesburg and other cities of Illinois, and is constantly extending its operations. The Springfield-Quincy branch will open up an entirely new territory, besides affording valuable connections.

UNITED GAS IMPROVEMENT COMPANY LOSES A POINT IN AN IMPORTANT LEGAL PROCEEDING—Judge Lanning, in the United States Circuit Court, on September 13 filed an opinion at Trenton, N. J., remanding back to the Court of Chancery the suit brought by Adam H. Groel to compel the United Gas Improvement Company to render an accounting of the entire issue of $20,000,000 worth of stock of the United Electric Company, issued at the time this latter corporation was organized in 1899. The case had been transferred from the Court of Chancery to the United States Circuit Court on technical grounds advanced by the defendant, it being alleged by counsel that at the time the process was served originally the United Gas Improvement Company had withdrawn its agent in New Jersey, and that the United Electric Company should have been made a codefendant. At the time of the organization of the United Electric Company, in March, 1899, Mr. Groel was a stockholder in the People's Light and Power Company, which afterward merged into the United Electric Company. In October last Mr. Groel commenced suit against the United Electric Company and the United Gas Improvement Company, alleging that the United Gas Improvement Company promoted and organized the United Electric Company in 1899 and made a secret and fraudulent profit which constituted virtually the entire capital stock of $20,000,000 of the United Electric Company. The United Gas Improvement Company contended that the United Electric Company should be treated as a complainant, because of the fact that Mr. Groel's suit was designed to compel the United Gas Improvement Company to pay back to the United Electric Company money which it had realized out of the sale of the stock.

TELEPHONE AND TELEGRAPH.

ALBANY, ORE.—The Independent Telephone Company will install a complete system this fall.

SCRANTON, PA.—The Anthracite Telephone Company, of Forest City, has connected with Carbondale.

ST. JOHN, NEB.—The Central Telephone Company has purchased the St. Martins telephone line.

CLEVELAND, OHIO—Work has been started on a branch exchange for Lakewood, to cost $150,000.

RICHLAND, GA.—The Southern Bell Telephone Company is installing an improved system in this city.

SEATTLE, WASH.—The Independent Telephone Company, of this city, has connected with Vashon Island.

NEWTONIA, MO.—The Enterprise Telephone Company is building a direct line from Newtonia to Neosho.

BALCOM, N. Y.—The Inter-Ocean Telephone Company is running a line from South Dayton to Cherry Creek.

PITTSBURG, PA.—The Central District and Printing Telegraph Company will enlarge its exchange at Sewickley.

HOLLIDAYSBURG, PA.—Citizens are considering the matter of organizing an independent telephone company.

SAN BERNARDINO, CAL.—N. W. Tarr has been granted a franchise to erect lines in San Bernardino County.

OMAHA, NEB.—The Hastings Independent Telephone Company is making arrangements to erect a $10,000 building.

FREMONT, NEB.—The city council has granted the application of the Fremont Telephone Company for a new license.

DOYLESTOWN, PA.—A telephone company has been organized at Boyerstown to reach Pottstown, Birdsboro and other towns.

PHILADELPHIA, PA.—Boyertown has organized a new telephone company, to reach Pottstown, Birdsboro and other towns.

DES MOINES, IOWA—The Rogers Telephone Company has been organized at West Union by Charles A. Towne and J. S. Jackson.

CORDELE, GA.—The Southern Bell Telephone Company is extending its system throughout the rural districts tributary to Cordele.

NASHVILLE, TENN.—A telephone exchange for Cornersville and vicinity has been established by the Cumberland Telephone Company.

COLUMBIA, TENN.—The Citizens' Telephone Company has completed the opening up of a new line up the Bear Creek pike to Lasea and points beyond.

RIVERSIDE, N. J.—It is stated that $5,000 will be spent here on the property of the Standard Telephone Company, which is now in the hands of a receiver.

WINDSOR, MICH.—The Walkerville town council has granted to the Bell Telephone Company a renewal of its exclusive franchise, which expires in December, 1906.

EDWARDSVILLE, ILL.—The independent companies of Richland, Jasper, Crawford and Lawrence counties have been consolidated with a capital of $100,000.

FLINT, N. Y.—The Empire State Telephone and Telegraph Company is placing poles in this section on a part of the through line from Rochester to Syracuse.

HARTWICK, N. Y.—The Hartwick Telephone Company is extending its line toward Burlington, and will shortly make traffic arrangements with the Wharton Valley line.

ONEIDA, N. Y.—At a meeting of the board of public works, a franchise was granted to the Rome Home Telephone Company to extend its long-distance line through the city.

EL PASO, TEX.—The Nacogdoches & Southeastern Telegraph and Telephone Company is planning to construct a telephone system along the line of the Nacogdoches & Southeastern Railway.

OCEAN PARK, CAL.—The Home Telephone Company has been granted a franchise along the Ocean Park speedway, the work of installing its system to be completed in a year.

SPOKANE, WASH.—The Pacific States Telephone and Telegraph Company has announced the construction of a line to Mohler. The line, it is stated, will be extended from Fletcher.

PHOENIX CITY, CAL.—The Consolidated Telephone, Telegraph and Electric Company will shortly commence construction work on a telephone line to connect Phoenix with Los Angeles.

GREEN BAY, WIS.—The Valley Telephone and Telegraph Company has been granted a franchise to operate an independent telephone system in this city. It is proposed to spend $200,000 at once.

STERLING, ILL.—The stockholders of the Yorktown Telephone Company have elected the following board of directors: George Matthis, M. R. Thackeberry, George Burden, P. S. Johnson and R. B. Senseny.

MOBILE, ALA.—The American Telephone and Telegraph Company has begun work on a new long-distance circuit from Mobile to New Orleans. The company is also extending its lines from this city to Meridian, Miss.

LEXINGTON, VA.—The Lexington town council has granted a new thirty-year franchise to the Lexington Mutual Telephone Company to go into effect August 1, 1905. The company will at once commence the enlargement of its plant.

WATERTOWN, N. Y.—Articles of incorporation of the Union Telephone Company have been filed in the county clerk's office. The company has a capital of $1,000, and purposes to maintain a telephone line between Point Peninsula and Three Mile Bay.

ARDMORE, I. T.—The Missouri & Kansas Telephone Company is building an extensive system of long-distance telephone lines in the Indian Territory and Oklahoma. The lines will run from Oklahoma City to Denison, Tex., crossing the Chickasaw reservation.

MARYSVILLE, OHIO—The United States Telephone Company has shipped eight tons of heavy copper wire to Marysville, to be used in constructing the new circuit between Columbus and Toledo. The company is planning another local circuit between Marysville and Kenton.

DETROIT, MICH.—The Ontario Independent Telephone Company, of Essex County, has been granted a twenty-year franchise by the council of the township of Sandwich West. The company agrees to pay the township a yearly rental when 100 or more subscribers are secured.

CLARKSBURG, W. VA.—The Consolidated Telephone Company has completed the work of building a new line from Philippi to Belington, and is now at work on a line from Grafton to Belington. When this is completed there will be an entire metallic circuit from Grafton to Elkins.

WOOD RIVER, NEB.—The Farmers' Home Telephone Company is extending its line east to meet the extension the Grand Island company is building. When the line is completed it will connect the independent system in Buffalo and adjoining counties with the systems at Lincoln and other points in the state.

RACINE, WIS.—The organizing of the Union Grove & Paris Telephone Company completes a system of independent telephone lines in Racine County. These lines will be connected with exchanges in Racine and Kenosha, and within a few months, it is said, a line is to be built into Milwaukee. The farmers throughout the county are the principal stockholders.

PITTSBURG, PA.—Work on the Pittsburg & Wheeling company's line is being pushed. All rights of way have been secured between Bridgeville and Washington to Wheeling. The new line will pass through Claysville, West Alexander and many smaller towns. It will cross Chartier township between Washington and Gretna, connecting with Canonsburg, Carnegie and Mount Lebanon.

BIRMINGHAM, ALA.—At a special meeting of the stockholders of the People's Telephone Company, a favorable vote was taken on the proposition to cancel the present authorized issue of bonds, amounting to $100,000, and to issue $200,000 of five per cent twenty-

year gold bonds. The proceeds will be used to pay off the present indebtedness of the company, and provide funds for the future growth and extension of the plant.

NASHVILLE, ILL.—The Southern Union Telephone Company, of this city, has disposed of all its lines in Coulterville to the Coulterville Telephone Company. The new company has organized with the following officers: president, J. I. Higgs; secretary, C. N. Laubenheim; treasurer, R. M. Bruns. The company will now proceed to extend the line to Marissa and secure connection with St. Louis over lines of the Bell company.

MONROE, WIS.—The Monroe Telephone Company has made arrangements to connect with the Wisconsin Telephone Company, giving the local company's subscribers long-distance service. The Bell company has abandoned its local office, and its business will be conducted by the independent company. A similar arrangement has been made by the United Telephone Company, which has exchanges at South Wayne, Blanchardville, Monticello and Albany, and which also conducts a number of farmers' lines.

OAKLAND, MD.—The farmers in the southern section of Allegany County and the adjoining territory of West Virginia have organized a mutual telephone company, to be known as the Red House Telephone Company of Garrett County. Its lines will extend to the line of the West Virginia Central Railroad, and cover the southern section of this county. Henry Sisler, of Red House, is president, and P. F. Snyder, of Sunnyside, is secretary.

WILKESBARRE, PA.—Work has been started on the construction of the conduits for underground wiring for the Pennsylvania Telephone Company. All of the work contemplated will not be done at this time, but it is anticipated that in the near future the board of directors will grant an expenditure of about $125,000 for the installation of a complete modern equipment. The company has recently made an expenditure of $200,000 in the Scranton district.

NEWBURGH, N. Y.—The State Line Telephone Company has completed its lines so as to connect with the Sharon company, and has also built a line to Pine Plains. The company is now building an extension to Shekomeko, and as soon as this is completed will commence the construction of a line from Poughkeepsie to Arlington, and south across Putnam into Westchester County. Right of way has been secured from Sylvan Lake to Fishkill Landing and Matteawan.

COLFAX, WASH.—Articles of incorporation of the Interstate Telegraph and Telephone Company, capitalized at $5,000, have been filed with the county auditor. J. J. Stephens, of Thornton, is president; Nelson Howard, treasurer, and T. A. Swain, of Pine City, is secretary and general manager. Lines will be built from Pine City to Thornton, and thence to St. John, and eventually the system will be extended so as to cover all of the towns in Palouse County. Work is to begin in the immediate future.

BINGHAMTON, N. Y.—The recently organized Maine & Union Telephone Company is progressing rapidly with the construction of its lines, and expects soon to have wires strung to Maine. The officers of the company are: president, Wayne Woodward; vice-president, L. W. Pitkin; secretary, Clarence Stevens; treasurer, E. M. Stevens. The new line will connect at Union Centre with the line from Newark Valley, and when the line to Maine is completed, connection can be made with the Glen Aubrey line and from there to Mt. Ettrick and Whitney Point. The central office will be at Union.

COLUMBUS, OHIO—At a meeting of the directors of the Columbus Citizens' Telephone Company, it was decided to issue $300,000 worth of six per cent preferred stock. The proceeds derived from the sale of this stock will be used in making needed improvements, such as installing an automatic switchboard and erecting new central stations. The company now has seventy-nine miles of conduits in Columbus, 8,000 poles and 4,000 miles of wire outside of the cable system. Over 5,000 subscribers are now connected. The new switchboard, which will have an ultimate capacity of 19,000 telephones, will be installed in February, 1905.

KANSAS CITY, MO.—Fifty tons of copper wire have been ordered by the Missouri & Kansas Telephone Company, to meet immediate requirements of its business in the Kansas City territory. Contracts have been made for a new building and enlarged plant at Hutchinson, Kan., which, with the underground conduit and new cable work, will cost $48,000. The company is also putting up a new building at Leavenworth, and will make additions to its plant costing $75,000. About $130,000 will be expended in St. Joseph. Many other improvements will be made. In cooperation with the Bell company, the Missouri & Kansas company will shortly build heavy copper circuits from Kansas City, through western Missouri, to Joplin, and thence through Indian Territory to Denison, to connect with the toll lines of the Southwestern company, which cover Texas.

NEW INCORPORATIONS.

WICHITA, KAN.—Arkansas Valley Interurban Railway Company. Increased to $2,100,000.

COLUMBUS, OHIO—Trotwood Home Telephone Company. Increased from $10,000 to $20,000.

MOBILE, ALA.—Gulf Electric Company. $20,000. Officers: C. W. Chase, president; R. W. Jones, secretary and treasurer.

RICHMOND, VA.—Hampton & Yorktown Railway Company; to construct an electric line between Hampton and Yorktown. $500,000.

CANASTOTA, N. Y.—Canastota Telephone Company. $25,000. Directors: C. J. Wood, T. H. Ferris, Utica; J. W. Souter, Canastota.

HALLOCK, MINN.—The Hallock Light Company. $15,000. Incorporators: Edward McVean, Peter H. Konzin, T. M. George and others.

SANTA FE, N. M.—The Albuquerque Electric Power Company. $50,000. Incorporators: William L. Iliff, William B. Childers and Edward Callen.

NORTH CREEK, N. Y.—North Creek Telephone Company. $10,000. Incorporators: C. A. Pereau, W. T. Campbell, James L. Fuller, of North Creek.

BOLIVAR, OHIO—The Tuscarawas Valley Telephone Company. $2,000. Incorporators: Earl Fisher, J. W. Keel, C. J. Pfau, S. B. Hennis and H. S. Fisher.

ST. PAUL, MINN.—The Minnesota Central Telephone Company; increased to $1,000,000. The Albert Lea Telephone Company; increased from $10,000 to $30,000.

NORMAN, OKLA.—The Farmers' Central Telephone Company. $5,000. Incorporators: G. E. Fuller, J. W. Abscher, of Franklin, and J. P. M. Ham, of Norman.

RICHMOND, VA.—Toluca & Fredericksburg Telephone Company. $5,000. Incorporators: R. A. Moncure, Hugh Adie, T. G. Waller, T. J. Moore and Wesley Knight.

SALAMANCA, N. Y.—Salamanca Electric Traffic Company. $20,000. Incorporators: William P. Phinney, Englewood, N. J.; P. C. Benedict, John J. Inman, Salamanca, N. Y.

NEWARK, OHIO—The Newark Heat and Light Company, $1,000. Incorporators: Augustus H. Heisey, George D. Heisey, E. Wilson Heisey, George F. Graeser and James R. Fitzgibbon.

LOS ANGELES, CAL.—The Southern California Electric Company. $25,000. Directors: F. W. Peschke, J. L. Ruperd, H. L. von der Kuhlen, J. C. Rendler and C. W. von der Kuhlen.

COLUMBUS, OHIO—The Richwood & Magnetic Springs Railway Company. $50,000. Incorporators: Christopher Magee, Jr., William M. Galbraith, John B. Taggart, Edward S. Mendenhall and John C. Miller.

MONTGOMERY, ALA.—The Inter-County Telephone Company. $2,000. Incorporators: C. E. and C. B. Hogeboom, Gus May, A. M. Lewellen, H. C. Simpson, J. B. Crowder, E. K. Chume, William Stringer, R. D. Chum and others. The company will operate telephone lines in Morgan and Madison counties.

MADISONVILLE, KY.—The Kentucky Midland Railroad Company. $1,000,000. Incorporators: P. J. and R. J. Jennings, of Portland, Ore.; E. D. Trenholm, of Spokane, Wash., and B. E. Wood

and J. Erb, of Beloit, Wis. The company will construct a line from Madisonville to Central City, in the county of Muhlenberg.

DYERSVILLE, IOWA—The Dyersville & Northern Railway. $75,000.

AUSTIN, TEX.—Kansas City, Oklahoma & Houston Railway. $125,000.

SAVANNAH, MO.—The Missouri Valley Electric Company has been incorporated in this city.

MADRID, IOWA—The Madrid Electric Light and Power Company has increased its capital stock to $15,000.

CONCORDIA, KAN.—The Home Electric and Power Company has succeeded to the business of the Concordia Electric Light Company.

CHICAGO, ILL.—Van Buren Electric Light Company. $50,000. Incorporators: Howard D. Malse, Thomas F. Low and Harold M. Dewar.

KIRKLAND, ILL.—Farmers' Union Telephone Company. $2,500. Incorporators: William Van Wert, John Paulson and W. N. Thompson.

RIVERSIDE, CAL.—The annual report of the electric light department of the city of Riverside, for the year ending June 30, 1904, shows total earnings of $84,850.69, and operating expenses of $62,876.17, leaving a balance of $21,974.52.

ST. PAUL, MINN.—Artichoke & Correll Telephone Company. $10,000. Incorporators: Charles Hanson, Fred Tobeck, Peter Bentson, Dedrich Carlson, Edward W. Robertson, O. A. Vig, C. J. Olson and John A. Jorgenson, of Artichoke Lake, and C. A. Johnson, of Correll.

LEGAL NOTES.

NEGLIGENCE OF A PEDESTRIAN—In the case of the Kansas City-Leavenworth Railroad Company *vs.* Gallagher, the Supreme Court of Kansas held that a person who crosses an electric street railway track in front of an approaching car which he sees and hears, is not negligent if, in view of his distance from the car, the rate of speed of its approach and other circumstances, a reasonable man would undertake the risk and attempt to cross.

LIMITATIONS OF TRANSFERS—In the case of Hornesby *vs.* the Georgia Railway Company, the Supreme Court of Georgia held that where a street railway company permits passengers to transfer from one car to another and continue their journey without payment of an additional fare, it is reasonable to require as a condition to the exercise of this right, that the passenger shall tender to the conductor of the second car a printed transfer check which must be used within the time indicated by punch mark on the check, provided a car upon which the passenger can be conveniently and comfortably transferred passes the transfer point within the time so limited; that a person who fails to comply with such requirements and who refuses to pay fare can not recover for an expulsion from the car when he does not show that his failure to have a valid transfer check was due to the fault of some employés of the company having authority in such matters, and that no recovery can be had where the initial car does not reach the transfer point until after the time indicated by the punch mark on the check, and the passenger voluntarily leaves the car before it reaches the transfer point and makes an unsuccessful attempt to walk to the transfer point before the time limit expires. In such case the court held that it is the duty of the passenger to remain on the car and give the conductor an opportunity to make arrangements for his transportation on the transfer car, and this is true even though it is the custom of the company not to issue new transfer checks where the initial car is delayed.

OBITUARY NOTICES.

PHILIP W. MOEN, at one time general manager of the Washburn & Moen Wire Works, and recently vice-president and director of the American Steel and Wire Company, died in Shrewsbury, Mass., September 12, at the age of 47.

MR. EDWARD HUBER, president and founder of the street railway lines of Marion, recently sold to the Columbus, Delaware & Marion Railway Company, and a prominent manufacturer of Marion, Ohio, died in the earlier part of the month.

ENGINEERING SOCIETIES.

THE NORTHEASTERN IOWA TELEPHONE ASSOCIATION—The annual meeting of the Northeastern Iowa Telephone Association was opened at Independence, Iowa, September 9, 1904. Papers were read and discussed by O. F. Blazier, Rockford; A. H. McClure, of West Liberty; E. C. Hampton, of Marion; I. J. Elgin, of Monticello, and Z. G. Houck, of Bellevue.

AUTOMOBILE NOTE.

FALL TOUR TO DELAWARE WATER GAP, ATLANTIC CITY AND LAKEWOOD—The question of having a fall tour has been discussed by the runs and tours committee, and it has been decided to submit this question to the members of the Automobile Club of America for a decision. Providing a sufficient number of favorable replies are received, stating that members will participate, the tour will be held; otherwise the club will abandon the idea of having one this fall. In case such a run is held, it is proposed to start it on Monday, October 10, two days after the Vanderbilt race, and take a five days' trip, including Port Jervis, Delaware Water Gap, Philadelphia, Atlantic City, Lakewood and New York. Emerson Brooks is chairman of the runs and tours committee, 753 Fifth avenue, New York city.

PERSONAL MENTION.

MR. ERNEST J. LAUGHAM has been appointed superintendent of the city electric plant by the water board of Cumberland, Md., to succeed F. P. Lawler.

MR. J. N. TRENHOLME, of the Northwest Commercial Company, Seattle, Wash., is the manager of the floating exhibition which left Seattle on September 15.

MR. G. MARCONI arrived in New York on Sunday, September 18, on the steamer Arabic. Mr. Marconi will visit his Cape Breton station before returning to Europe.

MR. W. E. McKINNON, superintendent of the City Electric Light and Waterworks, at Halletsville, Tex., has resigned his position and will take charge of a plant at Coleman.

MR. T. P. CHADWICK, of the testing department of the General Electric Company, sailed last week on the steamer Baltic for Lancashire, England, to visit his former home and parents.

MR. GEORGE C. RUTLEDGE has resigned his office as superintendent of public service, at St. Cloud, Minn., and accepted the position of manager of the electric light plant at Fargo, N. D.

MR. R. B. WATSON, formerly purchasing agent of the Michigan State Telephone Company, has been promoted to the position of local manager. Mr. G. S. Johnson, whom he succeeds, will remain with the company.

MR. RICHARD E. LYMAN has resumed his place as professor of civil engineering at the Utah State School of Mines after an absence of two years in which he studied at the universities of Chicago and Cornell.

MR. F. SEJERSTED is visiting America at the request of the Norwegian government railways to study the application of electricity to railway service in anticipation of the conversion of the government roads from steam to electricity.

MR. E. U. HARLAN, Monterey, Mexico, has been appointed manager of the Monterey Electric Street Railway, Light and Power Company, recently formed for the purpose of converting the horse car systems at Monterey into electrically driven lines.

MR. GEORGE MERRY VARELA, Santiago, Chile, who was commissioned by a number of South American governments to report to them on the industries of Europe and America, has completed his European trip and is visiting the United States en route home.

MR. S. B. LIVERMORE, formerly superintendent of the Winona Railway and Light Company, has been appointed superintendent of the La Crosse City Railway Company, succeeding Mr. Peter Valier who has accepted a position with the La Crosse & Southeastern Railway Company.

MR. FRANK A. LEACH, JR., who has been acting as assistant to Mr. John A. Britton for the past six years, has been appointed manager of the Oakland (Cal.) Gas, Light and Heat Company. Mr. Britton has been appointed manager of the California Gas and Electric Corporation.

MR. J. K. ROBINSON, of Iquique, Peru, a dealer in American machinery and electrical apparatus, will arrive in America and is expected to bring some large orders. His headquarters will be at the offices of the William E. Peck Company, Centennial Building, 116 Broad street, New York.

MR. W. E. GILMORE, vice-president of the Edison Manufacturing Company, Orange, N. J., and New York city, returned last week from an extended trip throughout the West. Mr. Gilmore is very much pleased with the improved prospect for a busy season throughout the entire country.

MR. N. COE STEWART, JR., Cleveland, Ohio, will direct the construction of an electric railway from La Paz, Bolivia, to a point in the mountains. Mr. Stewart has for some time represented eastern electrical interests in Peru. He served some time with the Brush Electric Company in Cleveland after leaving college and is well fitted for the work which he is to do.

MR. W. W. McCLEARY has been appointed division superintendent of the Monongahela Light Company, with headquarters at the Rankin, Pa., power plant. He will have charge of the development of the electric lighting business in McKeesport, Rankin, Wilkinsburg and adjacent boroughs. He was formerly general superintendent and general agent of the Monongahela company. For three years he was connected with the West Penn Lighting Company, operating at Irwin, Jeannette, Greensburg, Scottdale, Mount Pleasant, Connellsville, Dawson and Uniontown. He was at one time superintendent of the Braddock Gas and Electric Light Company, which controlled and operated the Citizens' Electric Light Company, of Braddock, and the Turtle Creek Light and Power Company. He was also general manager of the McKeesport Light Company.

MR. GUIDO PANTALEONI, who has been for some time manager of the St. Louis office of the Westinghouse Electric and Manufacturing Company, has been relieved of these duties in order that he may act as the personal representative of Mr. Westinghouse during the St. Louis exposition in the reception and entertainment of distinguished visitors. He has been appointed general southwestern manager of the company, in which capacity his duties will be with the large financial interests of the Southwest. Mr. William Clegg, Jr., who has for the past five years been the active man in the St. Louis territory as Mr. Pantaleoni's associate, has been advanced to be special agent for the handling of the specially important contracts in the field. This mark of the high regard in which Mr. Clegg is held by the company is due to his excellent record, and to the desire to leave him free from executive duties coming upon a district office manager, so that his ability as a salesman may have a wider scope. Mr. D. E. Webster comes from the Denver office to be acting manager of the St. Louis office. During his eleven years with the Westinghouse company, Mr. Webster has held a number of important positions, including that of chief of the testing department at East Pittsburg, so that he brings to his new office ability as an engineer as well as commercial experience.

ELECTRICAL SECURITIES.

Not since the boom period of 1902 has the market shown such animation and continued buoyancy. While it is announced from some quarters that the speculation of the past week was considerably due to manipulation, it is also a fact that this animated buying lasted entirely throughout the week. The transactions in last week's stock markets were evidently professional, as the public has not been attracted by even the recent large dealings. Nearly all of the leading securities have shown net gains for the week, and the general average of prices is only slightly below the high level for the year.

The foreign trade and its outlook, as indicated by recent and present tendencies, is not wholly reassuring. The statistics of foreign trade in August are discouraging, with an excess of merchandise exports the smallest of any month for many years. This excess amounted to $5,176,000, as compared with $7,397,000 for the same time a year ago. Domestic exports alone decreased $4,000,000 for the month of August. This being the case, it is evident that other exports did not suffer so heavily. The imports for August were valued at $87,511,000. This is nearly the largest total ever attained during the month of August. While it will not be conceded that the showing in exports is evidence of a falling off in the demand for the manufactures of this country, it is held that the good showing in imports is an indication of increasing consumption and demand in the United States, which is in line with other evidences of improvement in the country's industrial outlook.

ELECTRICAL SECURITIES FOR THE WEEK ENDING SEPTEMBER 17.

New York:	*Closing.*
Brooklyn Rapid Transit	55⅝
Consolidated Gas	205
General Electric	170
Interborough Rapid Transit	147¼
Kings County Electric	182
Manhattan Elevated	153½
Metropolitan Street Railway	121⅞
New York & New Jersey Telephone	155
Westinghouse Manufacturing Company	180

The annual stockholders' meeting of the Western Union Telegraph Company will be held October 12. The regular quarterly dividend of 1¼ per cent is payable October 15 to stockholders of record September 20. Books reopen October 14.

The balance sheet of the Westinghouse Electric and Manufacturing Company as of June 30, 1904, shows assets of $49,378,477, and liabilities of $37,766,728, leaving a surplus of $11,611,749.

Boston:	*Closing.*
American Telephone and Telegraph	138
Edison Electric Illuminating	258
Massachusetts Electric	59½
New England Telephone	130½
Western Telephone and Telegraph preferred	90

The Boston Elevated had a record-breaking month in August. Gross earnings were nearly $1,100,000, a gain of $133,000 over August last year. The gain was largely due to the "G. A. R." encampment.

The annual figures of the Edison Electric Illuminating Company of Boston for the year ended June 30, 1904, show that the company's business last year was the largest and most profitable in its existence. The past year's figures include for the first time the full year's business of the company's suburban properties, with the exception of the Somerville and Woburn companies. The Somerville operations are included since January 1, 1904, while the Woburn is still being operated as an independent plant. There was an increase of fifteen per cent in the gross business, while net earnings increased ten per cent. The statement of earnings compares as follows: income from sales of light and power, $3,114,623; expense, $2,065,756, leaving net of $1,058,867; other income, $10,893, a total of $1,069,760; interest, miscellaneous charges and dividends, $1,058,217, making the surplus for the year $11,543, as compared with a deficit of $20,320 for 1903. During the year the company increased its capital $1,813,600, making the total stock outstanding $10,444,500.

Philadelphia:	*Closing.*
Electric Company of America	9⅝
Electric Storage Battery common	65
Electric Storage Battery preferred	65
Philadelphia Electric	7
Union Traction	55⅞
United Gas Improvement	94¾

United Gas Improvement directors have declared a regular quarterly dividend of 2 per cent, payable October 15 to stock of record September 30.

Chicago:	*Closing.*
Chicago Telephone	122
Chicago Edison Light	150
Metropolitan Elevated preferred	59
National Carbon common	35
National Carbon preferred	107
Union Traction common	7
Union Traction preferred	31¼

It is reported that the first half of September made a fair showing in traffic of the elevated railroad lines, although the volume is said to be slightly less than it was a year ago for the same period. During the past three or four years the various companies have had a normal gain from month to month, ranging between three and eight per cent over the corresponding period of the preceding year.

ELECTRIC LIGHTING.

FLORENCE, GA.—A $50,000 electric light and power plant will be established here.

HUTCHISON, KAN.—F. W. Casner, of Kansas City, will apply for an electric light franchise.

DANVILLE, KY.—The city council has voted to substitute electric lights for gas throughout the city.

WHITESBORO, N. Y.—The Utica Gas and Electric Light Company has extended its wires to this village.

ROCHESTER, N. Y.—Penn Yan has voted to install an electric light plant, at a cost not to exceed $35,000.

WAVERLY, IOWA—It is reported that the town may vote on the question of installing a municipal electric light plant.

CLEVELAND, OHIO—The city lighting department is engaged in installing about 600 lights in the Newburg district.

MARYVILLE, TENN.—J. Burger, J. Walker, James A. Goddard and others will install an electric lighting plant in this village.

ROCHESTER, N. Y.—The Rochester Railway and Light Company has been awarded the contract for lighting the City Hall and central police station, etc.

STEVENS POINT, WIS.—The city has awarded an $18,000 contract for the installation of an electric lighting plant. About 500 horse-power will be developed.

RICHMOND, IND.—The city is now lighting its own streets. The municipal plant was constructed three years ago, but heretofore had been devoted to commercial lighting.

WESSON, MISS.—The Wesson electric lighting plant has been placed in operation. When completely equipped, the plant will have a capacity of fifty arc lights and 1,200 incandescents.

BALTIMORE, MD.—The municipal electrical commission proposes to spend $200,000 next year in extensions to the subway system. The commission will require about 800,000 duct-feet of material.

BURLINGTON, VT.—It is expected that Burlington's new municipal lighting plant will be in operation in April of 1905. Plans for the building are being prepared, and bids for its construction will soon be advertised.

KINGSTON, ONT.—The light committee has decided to spend $7,700 on temporary repairs to the lighting plant recently acquired by the city. The general overhauling of the power-house will not be started till next spring.

MARION, IND.—A large force of men is at work on the new electric light and heating plant of the Marion Light and Heating Company. It is expected that the building will be completed and equipped by November 1.

MILWAUKEE, WIS.—The plan of the Wisconsin Traction, Light, Heat and Power Company to purchase all the common and preferred stock of the Fox River Valley Gas and Electric Company has been ratified by the stockholders.

DANVILLE, KY.—Frank T. Synder, representing St. Louis capitalists, has been granted a franchise by the city council of Danville for an electric light and power plant. He was also granted a franchise for an electric railway.

PENDLETON, ORE.—The town of Echo is to have an electric lighting plant and waterworks system within a short time. Articles of incorporation have been filed for the Echo Water, Light and Power Company, capitalized at $10,000.

ELLSWORTH, ME.—The sixty-foot dam that was to have been built this year on Union river will be built in 1905. It is expected to develop 50,000 horse-power, which will be distributed all through this section, from Bangor to Bar Harbor.

AIKEN, S. C.—J. I. Linler has been granted a ten-year contract, with a perpetual franchise, to furnish twenty or more arc lights for the city of Waynesboro, Ga., at $85 per light. Mr. Linler is preparing to install a 100-kilowatt plant.

BURLINGTON, VT.—It is stated that work on the large electric power plant started by the Chittenden Power Company a few years ago will be resumed very soon. It is expected that between 3,000 and 4,000 horse-power will be developed.

CHEYENNE, WYO.—The machinery for supplying electric power to Fort D. A. Russell has been received by the Cheyenne Light, Fuel and Power Company. It is expected that the system will be in operation by the second week in October.

ATLANTA, GA.—Work on the dam of the Atlanta Water and Electric Power Company across the Chattahoochee river, at Bull Sluice, has been completed. The Georgia Railway and Electric Company has contracted for the entire output.

HARTFORD, CT.—The Norfolk Electric Light and Power Company has leased its plant in West Norfolk to the recently incorporated Canaan company. It is understood that the plant will be remodeled and enlarged so as to run night and day.

ALTOONA, PA.—At the annual meeting of the stockholders of the Home Electric Light and Steam Heating Company, the following officers were elected: president, J. J. Sullivan; vice-president, H. J. Crowley; secretary and treasurer, C. S. L. Tingley.

SALT LAKE, UTAH—James J. Chambers, of New York city, is reported to be projecting a power plant to be operated by energy secured from Little Cottonwood and Big Cottonwood creeks. It is expected that 2,800 horse-power will be developed.

PLATTSBURG, N. Y.—The board of public works has entered into a contract with H. A. Lozier, Jr., for street lighting. Eighty arc lamps of 2,000 candle-power are to be furnished for a period of five years from November 6, 1904, for $71 per light per year.

PURVIS, LA.—The Purvis Light and Power Company has been organized here with the following officers: W. H. Magee, president; J. W. Woodward, vice-president and general manager; C. V. Hathorne, secretary and treasurer. Machinery has been ordered for an electric light plant.

DOWNINGTON, PA.—The power plant of the Chester Valley Electric Light Company, owned by the West Chester Street Railway Company, has been leased to Harry B. McFarlan, of Downington. He will furnish power for the Downington trolley road and electric light for illuminating purposes.

DULUTH, MINN.—A syndicate consisting of J. K. West and E. G. Holmes, of Detroit, and other capitalists has purchased a large tract of land on both sides of the Otter Tail river, and a dam and reservoir will be built as soon as authority can be secured. Power will be supplied to Detroit and to local business interests.

FORTUNA, CAL.—L. M. Hancock has purchased the local electric lighting plant from the Humbolt Milling Company. The latter company had secured franchises for a pole line to Loleta, Rohnerville, Alton, Hydesville and Carlotta, and Mr. Hancock will carry out the work. The purchase price was in the neighborhood of $10,000.

BALTIMORE, MD.—The Baltimore County Electric Light and Water Company is erecting new poles and swinging brackets upon which to hang arc lights that are to take the place of the present incandescent lights of Highlandtown, Canton and Orangeville. According to the terms entered into with the county commissioner, the arc lights are to be in service by November 1.

COHOES, N. Y.—Joseph A. Powers and Walter H. Mansfield, of Troy, have purchased the real estate and electric lighting business of the Keeseville Electric Company. The company will continue to light Keeseville, Fort Kent and vicinity. The officers are: Joseph A. Powers, president; Walter H. Mansfield, vice-president; Thomas O'Connor, secretary; Walter H. Mansfield, treasurer and general manager.

CHICAGO, ILL.—The North Shore Electric Company, which supplies electric light and power to the territory of Evanston and Waukegan and intervening points, has decided to erect a large central power-house on the lake front at Waukegan to supply this region. It is expected that ground will be broken this fall. The building will be 125 by 214 feet, and it is stated that the plant will be one of the largest in the state. The company recently obtained a franchise for Lake Bluff, and expects to be serving that village in a few months. A pole line will also be run to Libertyville.

ELECTRIC RAILWAYS.

COLUMBUS, MISS.—A street railway is to be constructed here by F. M. Abbott, G. T. Heard, T. J. O'Neill and others.

DU BOIS, PA.—Work has been commenced on an extension of the local electric road to Sykesville, a distance of five miles.

SAN DIEGO, CAL.—It is stated that H. T. Richards is interested in a proposed electric railway from this city to Point Loma.

COOPERSTOWN, N. Y.—The Schenectady Railway Company proposes to extend its trolley line from Ballston to Saratoga at once.

RICHMOND, VA.—The Dayton & Western Traction Company is installing additional machinery in its power plant at West Alexandria.

LOUISVILLE, KY.—The Salt River Interurban Electric Railway, the new line of the Beargrass Railway Company, has been put in operation.

WILLARD, UTAH—The B. Mahler Company has been granted a franchise to construct and operate an electric railway through this place.

KNOXVILLE, TENN.—Work is being pushed on the reconstruction of the Atlanta, Knoxville & Northern Railway between this city and Wetmore.

NASHVILLE, TENN.—It is stated that the Nashville Railway and Light Company may extend its line some two and one-half miles along the Nolensville turnpike.

ERIE, PA.—A trolley line from Erie to Union City, through Waterford and Millvillage, is being built, and it is hoped to have it in operation before winter sets in.

KITTANNING, PA.—Work is now being pushed on the extension of the trolley road from Ford City to Christy's Grove, and it is expected that cars will be in operation by October 1.

HARTFORD, CT.—The Connecticut Railway and Lighting Company expects to have the Milford line double-tracked from Woodmont to Milford in time for next season's summer travel.

LEBANON, PA.—The Hummelstown & Campbelltown Street Railway will be placed in operation about October 1. The powerhouse at Derry Church is completed and ready for service.

PETERSBURG, IND.—The directors of the Vincennes & Jasper traction line have let the contract for building the road to the International Construction Company, of Detroit, for $1,000,000.

FITCHBURG, MASS.—The state railroad commissioners have notified the officers of the Leominster, Shirley & Ayer electric road that they may operate their line from Leominster to Ayer.

HANNIBAL, MO.—Preliminary surveys are being made on the proposed electric line from Hannibal to Quincy, Ill., and the promoters say that cars will be running over the line by January 1.

SALAMANCA, N. Y.—The Salamanca village board has granted a franchise to the Salamanca Electric Traffic Company to construct and operate a motor car line from East Salamanca to West Salamanca.

WATERBURY, CT.—The Waterbury section of the new trolley line which is being constructed between this city and Cheshire by the Cheshire Street Railway Company has been completed, and a service has been established between Waterbury and Mad river.

DETROIT, MICH.—J. D. Hawks, president of the Ypsilanti-Ann Arbor road, states that a new line will be built between Jackson and Lansing. Surveys probably will be completed this fall and construction started early in the spring. Several routes are in consideration.

NORFOLK, VA.—The Norfolk City & Suburban Railroad Company, which will operate an electric line between this city and the property of the Wheeling Development Company, near Indian River Gardens, has let a contract for the construction of a line three and one-half miles long.

BINGHAMTON, N. Y.—It is stated that arrangements have been completed whereby the building of the Binghamton & Southern road will be begun within a short time. The road is projected to run from Binghamton to Williamsport, and will connect with the Delaware & Hudson.

GALENA, KAN.—Work on a new electric line between Galena and Baxter Springs, Kan., has been commenced. It is reported that the new road will operate in conjunction with the Southwest Missouri Electric Railroad, giving a continuous line from Carthage, Mo., to Baxter Springs.

SOUTH McALESTER, I. T.—The Indian Traction Company has closed a contract to extend its line from Alderson to Haileyville and Hartshorne, I. T. The completed line from this place to Hartshorne will be seventeen miles in length. The additional line is to be completed within three months.

COLUMBUS, IND.—The Southern Traction Company, which purposes building an electric traction line between this city and Madison, states that the road will be constructed within the two years' limit set by the franchise. The line now being built from Madison to Hanover will be in operation by the end of the year.

DUBUQUE, IOWA—Articles of incorporation for a new electric railway in which Dubuque and New Vienna capital is interested, have been filed with the county recorder. It is to be known as the Dyersville & Northern Railway Company, and the object is to construct a line between Dyersville and New Vienna, and make such extensions as the company may deem advisable in the future.

PITTSBURG, PA.—An ordinance has been passed by the Clairton council, granting to the Clairton Street Railway Company the right to construct, maintain and operate a street passenger railway on certain streets in the borough. The road will be a branch of the Charleroi line, and will join that line at Library. The line, according to the borough ordinance, must be begun within sixty days and be completed within one year, under penalty of forfeiture of franchise.

CLINTON, N. J.—There is a movement on foot to build a trolley line between this place and Frenchtown, connecting other towns along the Delaware. The Northampton Trolley Company, which is building the line from Easton to Washington, has the matter under consideration, and if the project is carried out a line will be built from this place to Washington, connecting High Bridge, Glen Gardner, Junction and Changewater. A branch will also be run to Flemington.

DOVER, N. J.—The Hanover township committee has granted a franchise to the Delaware Traction Company to run a trolley over eight miles of township roads, beginning at Collinsville and running through Malapardis, Whippany and Hanover to Cook's bridge, the dividing line between Morris and Essex counties. It is supposed to be the intention of the company to connect with the public service line, and, if so, the connection will be made at West Orange and Singac.

YORK, PA.—It is stated that the extension of the New Cumberland & Mechanicsburg street railway system into York County is assured, arrangements having been made by the directors with the Trust Company of North America for financing the corporation. The street railway company has planned to build a bridge across the Susquehanna, near New Cumberland, and from that place the line will be extended to Lewisberry. Later on it is planned to complete the extension from York Haven to Lewisberry, giving a through route from York to Harrisburg.

ROCHESTER, N. Y.—The right of way over a large tract of land east of Brighton has been obtained by the Rochester, Syracuse & Eastern Railway Company. The company plans to build a viaduct over the creek and work probably will be started within a few months. The structure will be of concrete and steel. The new road has now obtained the right of way between Brighton and Newark, with a few exceptions. Work has been started at several places between here and Auburn, and a large portion of the route is expected to be completed before the cold weather sets in.

MUNCIE, IND.—The Dayton & Muncie traction line, now operating between Dayton, Ohio, and Winchester, Ind., will reach Muncie not later than January 1, it is said, where connections will be made with the Indiana Union Traction line for Indianapolis and other important Indiana cities and with the Muncie, Hartford & Fort Wayne traction road for Hartford City, Montpelier and Bluffton, Ind. The line would have been operating into Muncie by this time but for the opposition of farmers between Muncie and Winchester, who objected to granting the right of way. Condemnation suits will be filed by the company.

INDUSTRIAL ITEMS.

THE BARRIETT ELECTRIC COMPANY, Cincinnati, Ohio, has published a very fine catalogue, bulletin No. 4, descriptive of Barriett motors.

MR. E. W. REYNOLDS, Los Angeles, Cal., is calling attention to the "Imperial Solderine." This is a soft solder which does not require any acid or fluid.

THE GLACIER METAL COMPANY, New York, has published a hanger giving in condensed form the presidential data of the various states of the Union.

THE C. W. HUNT COMPANY, West New Brighton, Staten Island, N. Y., in catalogue No. 047 describes and illustrates coal-handling machinery in all of its various forms.

THE NEW YORK CUT STONE COMPANY, New York city, presents in its bulletin for August, 1904, a half-tone illustration of the entrance to the Century Building, New York city, the front of which is made of South Dover marble.

THE WAGNER ELECTRIC MANUFACTURING COMPANY, St. Louis, Mo., has issued in book form the paper by W. A. Lyman entitled "Single-Phase Power Motors for Electric Lighting Stations," read before the National Electric Light Association, at Boston, Mass., in May.

THE ST. LOUIS EXPANDED METAL FIREPROOFING COMPANY, Century Building, St. Louis, Mo., has produced a leaflet giving results of tests of reenforced concrete beams at the University of Illinois. This material is taken from a paper by Professor Arthur N. Talbot, before the American Society of Testing Materials, June, 1904. The results are shown graphically in diagram.

JUAN B. SAMANIEGO & COMPANY, Peubla, Mexico, desires catalogues and price lists of electrical apparatus manufactured by American firms. This company is frequently requested by responsible parties in Cuba and Porto Rico for this material, and will be pleased to get in correspondence with American manufacturers, as it makes a business of distributing all kinds of printed matter of this nature.

THE AMERICAN ELECTRIC TELEPHONE COMPANY, Chicago, Ill., has recently equipped a number of independent exchanges with telephone and switchboard apparatus. Among other contracts, the following are announced: Monroe, La., 100-line switchboard; Tina, Mo., 100-line switchboard; North Loup, Neb., 200-line switchboard; Abingdon, Ill., 200-line switchboard; Hartford, Ct., 50-line switchboard; Erie, Kan., 400-line switchboard.

THE GOULD STORAGE BATTERY COMPANY, New York city, in bulletin No. 4, entitled "Regulating Battery in Connection with Water Power Plants," describes the power-house station and the existing conditions of the Easton Power Company, at Easton, Pa. This company uses a battery of 510 cells with a capacity of 1,040 amperes at 550 volts at the one-hour rate, or 572 kilowatts with a momentary capacity of 1,560 amperes or 850 kilowatts.

THE HOBART ELECTRIC MANUFACTURING COMPANY, Troy, Ohio, is distributing a neat circular descriptive of its direct-current dynamos and motors. Illustrations are shown of the protected type motor, which is built in sizes from one to twenty-five horse-power, the same type of dynamo being built in sizes from one to twenty kilowatts. An illustration is given of a belted multipolar type which, in motors, is built from 35 to 100 horse-power, and in dynamos from thirty to seventy-five kilowatts.

THE POPE MANUFACTURING COMPANY, Westfield, Mass., is distributing a booklet descriptive of multiple metal parts. This booklet announces that over a year ago the company opened a special department in its Westfield (Mass.) plant, for the manufacture of multiple metal parts. The company estimates on screw machine products, stampings, drop forgings, machining, enameling, brazing, polishing, lacquering, case-hardening, nickel-plating, special dies, tools, implements and new inventions. The booklet includes a ha. tone illustration of specimens of work in this line.

THE GENERAL ELECTRIC COMPANY, Schenectady, N. Y., is distributing the September issue of the "General Electric Review." This contains a number of descriptive articles of interest to engineers. The Sprague-General Electric automatic relay train control for the Boston Elevated Railway Company is described by G. H. Hill. This is illustrated by diagrams and half-tones. There is an interesting article entitled "A 'Pumping-Back' Installation," descriptive of an electric pumping plant that provides part of the power to drive itself. This is contributed by G. W. Redfield. Martin P. Rice is the editor; Joseph B. Baker, assistant editor, and Caryl D. Haskins, commercial conferee.

THE LAIDLAW DUNN-GORDON COMPANY, Cincinnati, Ohio, describes in bulletin L601 Myer-gear pumping engines for small waterworks and elevator service. These engines are built in cross-compound and three-cylinder compound types and with fork frames or rolling-mill frames. Their cost is said to be moderate. When running condensing with ordinary steam pressure they show an average steam consumption of less than twenty pounds per horse-power-hour, which would effect a saving, compared with direct-acting compound pumps, of about 130 tons of coal per year for every million gallons daily capacity. These pumping engines are said to have found a wide application in small waterworks plants and for circulating brine and hot water, feeding large boiler plants, etc.

THE SPRAGUE ELECTRIC COMPANY, New York city, announces that the electric light wires in the New York subway cars will run through the Sprague company's flexible metallic conduit. As the time approaches when the subway trains will be put in regular operation, interest naturally increases, and it is a source of satisfaction to the people who expect to travel in these cars to know that every precaution has been taken to prevent the cars from catching fire. The flexible metallic conduit is a tube formed by a succession of steel convolutions, which give not only great flexibility to the tube, but also, by the metal composition, a thorough protection to the insulated wires which it carries. Mechanical injury is thus prevented, and it is claimed that a short-circuit will produce no serious damage.

THE WESTERN ELECTRIC COMPANY, Chicago, Ill., is completing tests upon the Allen-Bradley electric crane controller. These tests have been going on for the past two or three months, and have involved practically every artificial test which could be given to the controller. As a result of these tests, the chief engineer of the Western Electric Company, Mr. Fowler, who had charge of the tests, reported that the Allen-Bradley electric crane controller operates successfully at its rated capacity, and that it stands successfully long-continued overloads of from fifty to one hundred per cent. Its regulation is said to be perfect, and its control absolute. The Western Electric Company is negotiating with the American Electric Fuse Company, Chicago, Ill., the manufacturer of the Allen-Bradley crane controller, for the production of this apparatus. It is probable that in the near future this machine will be placed upon the market under the Western Electric Company's guarantee, as standard Western Electric Company controllers. It is announced, however, that the American Electric Fuse Company will continue to furnish these controllers to its customers. The large demand for this apparatus has necessitated an enlargement of the factory equipment of the American Electric Fuse Company in its controller department. The company now has upon its books orders for over 500 of these controllers, varying from 3 to 100 horse-power in size.

THE DOUBLEDAY-HILL ELECTRIC COMPANY, Pittsburg, Pa., is issuing an attractive series of circulars prepared by one of the leading advertising experts. These circulars are particularly original and forceful. In the latest one issued the excellent handling, checking and shipping systems operated by this company are discussed, showing the reasons why its patrons may expect satisfaction as to the promptness and manner in which their orders are handled. It is the custom with this company to begin the packing of an order the day it is received and if it is a "rush" order, within an hour after it is received. This company has one of the largest and best equipped electrical establishments in the world, and in addition to complete lines of high-grade materials and equipments for lighting stations, telephone stations, electric railroads, contractors and mills, it has a perfectly equipped winding and repair department. The company is also exclusive agent in its territory for the following: A. B. arc lamps, General Electric incandescent lamps, O. K. weatherproof wire and cables, Triumph dynamos and motors, Emerson alternating-current fans and motors, Gardner electric rock drills, Packard transformers, Holophane glass, Nernst lamps and G. E. dynamos and motors.